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A web-based physical activity intervention for patients with knee and hip osteoarthritis

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A web-based physical activity intervention for patients with knee and hip osteoarthritis

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Een web-based beweegprogramma voor patiënten met knie en heup artrose

Proefschrift

ter verkrijging van de graad van doctor aan Tilburg University,
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Voor mijn ouders

Contents

1

General introduction

Knee and hip osteoarthritis

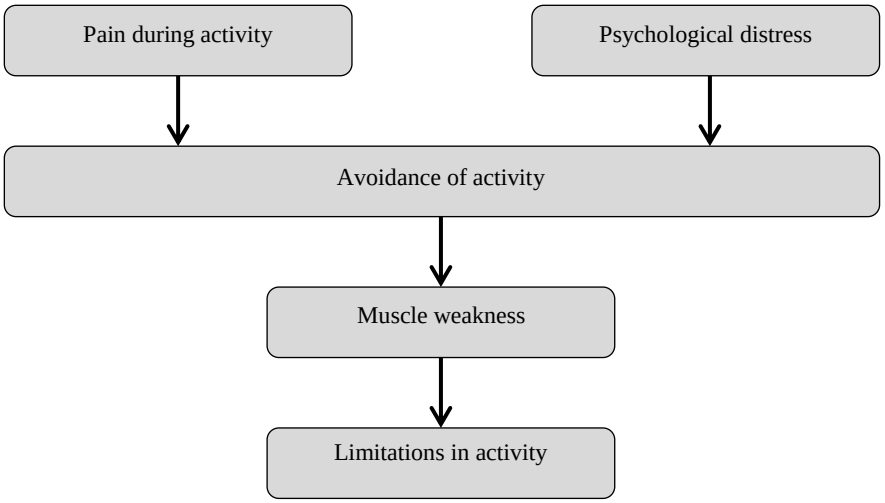
Osteoarthritis (OA) is worldwide one of the leading causes of pain and disability in the elderly [1]. The knee and the hip are two common sites of OA [2]. The lifetime risk of developing systematic knee or hip OA has been estimated to be respectively 45% and 25% [3,4]. Based on registrations by primary care physicians in the Netherlands, it is estimated that around 312.000 (19.1/1000) patients suffer from knee OA and 238.000 (14.6/1000) from hip OA [5]. Due to the ageing Dutch population, it is expected that the prevalence of knee and hip OA will be increased with 52% in 2040 [6]. Despite the amount of research that has been conducted, there is still much unknown about the etiology, onset and specific causes of OA. The pathogenesis of OA is thought to be multifactorial with genetic (heritability), constitutional (e.g. aging, female sex, obesity) and mechanical factors (e.g. joint injury or joint malalignment) playing a role. The pathology involves multiple changes in the joint components, including degradation of articular cartilage, changes in subchondral bone compartment, inflammation of the synovial membrane, occurrence of osteophytes and weakness of ligaments and muscles [7,8]. These modifications within the joint may lead to a gradual development of clinical symptoms. Pain is the most prominent symptom of OA. Other symptoms include morning stiffness, reduced range of motion and instability of the joint [7].

Physical activity in patients with knee and hip osteoarthritis

Physical activity, encompassing both structured exercised and lifestyle activities, is defined as any bodily movement produced by contraction of skeletal muscles that results in an expenditure of energy [9]. As OA progresses, patients begin to have difficulty with daily physical activities, particularly during weight-bearing activities such as walking and stair-climbing. These activities are seriously hampered by disease-related factors, like perceived pain [10] and fatigue [11]. This partly explains why patients with knee and hip OA are less physically active than the general population [12-15]. Besides disease-related factors, engagement in daily activities depends crucially on how patients cope with their symptoms [16]. The avoidance model is a framework which can be used to illustrate the effect of avoidance behavior on physical activity [17,18]. Patients who structurally

misinterpret pain sensations as a sign of joint damage tend to avoid physical activity because activity induces pain [19-21]. In the long term, physical inactivity may lead to deterioration of physical (e.g. muscle weakness, decreased physical capacity) and psychological health (e.g. reduced confidence, anxiety) and eventually to functional decline [22,23]. Consequently, these limitations can lead to further avoidance of activities (Figure 1). To preserve and improve physical function [24,25], physical activity promotion is a key element in the non-pharmacological treatment of patients with knee and hip OA [26]. Complementary to the disease specific benefits, a physically active lifestyle is also associated with a lower risk of other health problems such as, diabetes, heart disease and cancer [27].

Figure 1: The avoidance model [17]



The promotion of physical activity and its effectiveness

In general, regular physical activity and specific exercises are considered to be safely and beneficially for patients with knee and hip OA [28]. Exercise therapy, generally provided by physical therapists, is by far the most investigated form of physical activity promotion among patients with knee and hip OA. Exercise therapy is a plan or regimen of physical activities designed and prescribed for specific therapeutic goals. Its purpose is to restore normal musculoskeletal function or to reduce pain caused by OA

[29]. Two literature studies showed that exercise therapy interventions for patients with knee OA have moderate beneficial effects on pain and self-reported physical function [25,30]. These results are less conclusive in patients with hip OA [31,32]. However, the effects of exercise therapy are generally not sustained in the long term since adherence to exercise therapy typically declines over time [33]. Previous research has shown that walking programs, for example, positively impacts the function status and pain levels in patients with knee and hip OA [34,35]. The promotion of physical activity can be done through multiple manners, such as patient education, self-management materials, health counseling, telephone contacts, either individually or in various combinations. It is worth noting that certain high impact activities have no beneficial effects for individuals with knee and/or hip OA. Intensive physical activities, such as marathon running, professional athletics and occupational related kneeling and squatting are risk factors for the development of OA and may have an adverse role in patients with knee and hip OA [36-39]. Therefore, these intensive activities are not recommended in the non-pharmacological management of OA [40].

Working mechanisms of physical activity

Thus, it can be concluded that many forms of physical activity have positive effects on the physical function and pain scores in patients with knee and/or hip OA. While this effectiveness is well established, underlying mechanisms of physical activity are still scarcely understood. In literature, numerous theories are proposed which explain the beneficial effects of physical activity in patients with knee OA. Recently, a systematic review in patients with knee OA [41] found five broad health benefits of exercise therapy which are linked to the outcomes physical function and pain; 1) neuromuscular consequences (muscles, proprioception/ balance, energy absorbing capacity and stability), 2) peri-articular consequences (connective tissue and bone), 3) intra-articular consequences (cartilage, inflammation and joint fluid), 4) psychosocial consequences (depression and self-efficacy) and 5) general fitness and health (co-morbidity, weight loss and aerobic fitness). These abovementioned components can be positively affected by physical activity which may eventually lead to increased functional capacity and/or reduced levels of pain. It is most likely that an interplay of these

components explain the effectiveness of exercise. Obviously, this also depends on the purpose and content of exercise regimen. For example, exercise therapy which incorporates cognitive-behavioral techniques is more likely to affect psychosocial components than neuromuscular factors. Hereby, it is important to note that there is no benefit of one form of exercise type over another [42].

Physical activity as a non-pharmacological treatment

Supported by the effects of physical activity, national [43,44] and international [26,45] guidelines advocate that physical activity should be a key element in the non-pharmacological treatment of patients with knee and hip OA. Since approximately 70% of the Dutch population consult their general practitioner (GP) each year [46], GPs are ideally positioned to stimulate patients with knee and hip OA to adopt and maintain higher levels of physical activity. The promotion of physical activity may consist of provision of information and education. However, in practice, GPs' ability to promote physical activity is limited by crowded agendas and lack of standard protocols [47]. In particular, core elements concerning risks of a sedentary behavior are insufficiently emphasized. At the same time, it is unlikely that patients receive exercise therapy, since only 5% of the patients with knee and/or hip OA is referred to a physical therapist [48]. Consequently, numerous patients have negative concerns (e.g. fear of pain and catastrophizing thoughts) about the impact of physical activity on their joints and lack knowledge and skills to modify their physical activity routines [49,50]. Considering the lack of time and resources in the healthcare setting, self-help interventions to promote physical activity have become more and more important in the treatment of OA patients. These interventions are commonly referred as self-management interventions and characterized by active patient participation. Barlow and colleagues [51] define self-management as the individual's ability to manage the symptoms, treatment, physical and psychosocial consequences and lifestyle changes inherent in living with a chronic disease. Interventions which aim to enhance self-management typically encompass educational strategies, such as goal setting and problem solving, in order to change a health behavior [52].

Promotion of physical activity through internet

So, there is a substantial group of patients who is not in treatment, in this thesis defined as 'outside care patients, who lack knowledge and skills to change their inactive lifestyle. The internet offers a viable way to deliver self-help interventions to assist outside care patients in achieving higher levels of physical activity. The possibilities to provide behavior change interventions through the internet are increasingly explored. The Netherlands is one of the countries with the highest internet penetration rates together with countries like Norway, Australia, Sweden and Denmark [53]. In 2012, 93% of the Dutch population had access to internet services. Nowadays, internet is regarded as the most important source of health information [54]. As a result of the rapid growth of health information on the internet, the umbrella term 'eHealth' has emerged. eHealth refers to health services and information delivered or enhanced through the internet and related technologies [55]. EHealth provides a promising medium to enhance physical activity among healthy and chronically ill people. Internet-based resources have multiple persuasive tools which are useful to change physical activity behavior. Web-based interventions are mostly used in the field of physical activity promotion which are primary self-guided programs that typically provide automatically generated feedback. The key components of such interventions include program content, use of multimedia, interactive online activities and guidance [56]. Hundreds of such web-based interventions have already been developed to enhance understanding of health conditions and to change a physically inactive lifestyle. Previous research has identified that web-based interventions have the potential to improve physical activity in different populations [57-61]. On the one hand, web-based interventions have the potential of high reach, low costs and are accessible anytime and anywhere [56]. On the other hand, the absence of face-to-face interaction and lack of social control in web-based programs may reduce trust, intimacy and may lead to miscommunication and poor retention rates [56]. Another disadvantage is that those with a low socioeconomic status and low eHealth literacy are less likely to use web-based interventions [62]. This widely recognized phenomenon is called the "The inverse information law" [63].

Join2move

Given the advantages of internet and its unique ability to reach a large group of inactive outside care patients with knee and/or hip OA, web-based interventions seems to be promising in order to promote a physically active lifestyle. At this juncture, there are no web-based physical activity interventions for patients with knee and hip OA. We therefore developed Join2move (artroseinbeweging.nl). The Join2move intervention is an automated web-based intervention which aims to encourage moderate activities such as walking, cycling and swimming. High impact activities that may strain the knee and hip joint, such as running, jumping and other sports activities, were not included. The Join2move is based on the behavioral graded activity (BGA) program for patients with knee and/or hip OA [64]. The BGA treatment is a previously developed and evaluated exercise program. In this program patients' most problematic physical activities are gradually increased in a time contingent way despite the possible presence of pain. The constructs of the BGA treatment were the basis for the development of the Join2move intervention. The gradual increase in activities aims to improve physical activity levels in patients with knee and hip OA despite the potential presence of pain. This may eventually lead to positive physical (e.g. more muscle strength, more joint mobility and better endurance) and psychological changes (e.g. more self-esteem, less pain perception and less anxiety) and eventually improved physical function. More details of the Join2move intervention are presented in chapter 3 of this thesis.

Aim of the thesis

It can be concluded that eHealth, including web-based physical activity interventions, is a promising tool to optimize health in both a curative and preventative manner. Despite numerous of web-based interventions, research on the effectiveness is in its infancy and results (in terms of physical activity) are still inconclusive. According to the South African social rights activist, Desmond Tutu, "eHealth is a ray of light on the horizon for the health and equity challenges that plague humanity" [65]. Although there is much enthusiasm about eHealth and an enormous growth of web-based eHealth interventions, academic research on the development, uptake and

evaluation of physical activity web-based interventions is still scarce. More research is needed in this area to achieve the promise of web-based eHealth applications. The purpose of the research described in this thesis is twofold. First, to develop a web-based physical activity intervention for patients with knee and/or hip osteoarthritis. Second, to investigate whether a web-based physical activity intervention in patients with knee and/or hip OA would result in improved levels of physical activity, physical function and self-perceived effect compared with a waiting list control group.

Outline of the thesis

This thesis comprises a series of studies. The first study is a systematic review which is described in **chapter 2**. The aim of this literature study was to synthesize the existing evidence of the effectiveness of web-based physical activity interventions in patients with a chronic disease. In addition to summarizing the effects, the review aimed also to provide insights for the creation of a new web-based intervention for patients with knee and hip OA. Based on the knowledge obtained from previous studies, we developed the web-based intervention Join2move. During the period of one year, Join2move was developed through several stages of testing, analyzing and revising. This development process, including a pilot study and two usability tests, is outlined in **chapter 3**. To evaluate the effectiveness of the final version of Join2move, a randomized controlled trial was conducted. In this trial, 199 patients with knee and hip OA were randomly assigned to the Join2move intervention (n=100) or the waiting list control group (n=99). The primary outcome measures, physical activity, physical functioning and self-perceived effect, were measured on baseline, 3 and 12 months. The results of the RCT (randomized controlled trial) study are presented in **chapter 4**. During the RCT we observed substantial rates of nonusage. In **chapter 5**, we aimed to address the issue of non-adherence by means of a mixed methods study. The integration of results from the quantitative and qualitative methods identified factors related to the (non) usage of Join2move. **Chapter 6** investigates the correlation between changes in psychological factors and changes in physical activity in those who participated in the Join2move intervention. The results of this chapter provide information to researchers and practitioners with respect to which intervention components are important to increase the effectiveness of physical activity interventions.

The final chapter, **chapter 7**, provides a general discussion of the research presented in this dissertation and considers suggestions for future studies and implications for practice.

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2

The effectiveness of self-guided web-based physical activity interventions among patients with a chronic disease: a systematic review

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Abstract

Background Despite well documented health benefits, adults with a physical chronic condition do not meet the recommended physical activity guidelines. Therefore, secondary prevention programs focusing on physical activity are needed. Web-based interventions have shown promise in the promotion of physical activity behavior change. We conducted a systematic review to summarize the evidence about the effectiveness of web-based physical activity interventions in adults with chronic disease.

Methods Articles were included if they evaluated a web-based physical activity intervention and used a randomized design. Moreover, studies were eligible for inclusion if they used a non- or minimal-treatment control group and if physical activity outcomes measures were applied. Seven articles were included.

Results Three high quality studies were statistically significant to the control group, whereas two high and two low quality studies reported non-significant findings.

Conclusion Our best evidence synthesis revealed that there is conflicting evidence on the effectiveness of web-based physical activity interventions in patients with a chronic disease.

Introduction

Chronic diseases, such as osteoarthritis, type 2 diabetes and coronary heart disease, are a major cause of disability worldwide. A chronic disease negatively affects quality of life due to physical and psychological consequences [1]. With an ageing population in the western world, it is expected that the number of patients with a chronic disease will increase substantially [2].

Strong evidence indicates that physical activity (PA) has important health benefits for patients with a chronic disease, including reduced pain, improved function and a reduced risk of disability [3-5]. Moreover, PA has also been associated with psychological benefits and improvements in quality of life [6;7]. In general, PA is defined as any bodily movement produced by contraction of skeletal muscles that results in an expenditure of energy [8]. Regular PA is essential for healthy people and people with a chronic disease. Nevertheless, current estimates indicate that two thirds of the adult population in the European Union do not meet the recommended levels of PA [9]. Substantial evidence has confirmed that this percentage is even higher among patients with a chronic disease [10]. Therefore, PA is a public health priority and is considered as an essential component in the management of several chronic disorders. To enhance PA and maintain higher levels of PA in patients with a chronic disease, a variety of methods have been developed. Traditionally, PA behavior change interventions use face-to-face delivery or printed materials. Findings from a meta-analysis showed that these interventions are effective in the promotion of PA among chronically ill [5]. In particular, interventions based on a behavioral strategy (e.g. consequences, feedback, goal setting, self-monitoring) are more effective than interventions that do not include a behavioral component. Due to the increasing number of internet users [11] researchers and health providers focused on internet technology to induce health behavior change [12;13]. The internet has created opportunities to distribute cost-effective behavior interventions [14], which are 24 hours per day available and widely accessible. Moreover, the internet is convenient, anonymous and appealing for those who want to work in their own environment and in their own time

[15]. However, aforementioned advantages may also be viewed as limitations.

Although open access is one of the primary advantages of internet, it may also be a disadvantage for those who lack the skills to use the World Wide Web. Furthermore, absence of face-to-face interaction and lack of social control may reduce trust, intimacy and may lead to miscommunication and poor retention rates [16]. Although the number of Internet users is increasing, we should not be blind to the fact that most of the world's population (70%) does not have access to the internet [17]. In particular, elderly, unemployed, less educated [18;19] and those with a low eHealth literacy [20] have less access to computers and are less likely to use interventions through the internet.

Internet-based therapies differ in content and purpose. Barak et al. identified 4 different internet-supported interventions based on their mode of delivery [16]: (1) web-based interventions; (2) online counseling and therapy; (3) internet-operated therapeutic software; and (4) other online activities (blogs, online support groups). Web-based interventions and online counseling are mostly used in behavior change education [21]. Web-based interventions are primarily self-guided, while online counseling interventions require extensively trained therapists for personal guidance. While online counseling provides individualized guidance, web-based interventions have the potential power to reach a large population at low cost [16]. This unique advantage has led to the growth of numerous web-based PA interventions in recent years.

Previous research has identified that web-based interventions are successful in improving PA behavior in healthy adults [22-27]. These reviews revealed that, in general, web-based courses were superior to waiting list controls and equivalent to conventional interventions, even though effect sizes were small. Although considerable research has been devoted to healthy populations, rather less attention has been paid to PA website interventions among patients with a chronic disease. In comparison with healthy people, patients with a chronic disease have different motivations, abilities and

barriers with regard to PA [28]. People with a chronic disease perceive unique barriers, such as pain, fatigue and reduced physical performance capacity. These barriers vary among different patient populations [29;30].

Therefore, people suffering from a chronic disorder may have other perspectives, needs and desires with respect to PA promotion than healthy persons [33;32]. As a consequence, interventions focusing on healthy adults and the chronically ill differ in content. Because PA interventions for healthy adults focus on general PA determinants (e.g. health behaviors, time barriers and social support) [34], interventions for individuals with a chronic disease predominantly address specific PA barriers [34] (e.g. pain, fear of hypoglycemia, anxiety). To date, no reviews of PA web-based interventions among patients with a chronic disease have been performed. Therefore, the aim of this review is to summarize the effectiveness of web-based PA interventions in patients with a chronic disease.

Methods

Search strategy

A computerized literature search was performed using Pubmed (1966 to April 2011), CINAHL (1982 to April 2011), Embase (1980 to April 2011) and Cochrane Controlled Trial Register February 2011). The principal researcher (DB) carried out an initial database search to identify relevant articles. The search strategy consisted of combinations of free text and medical subject heading terms related to physical activity, the internet, chronic disease and intervention study. Keywords and medical subject heading terms used in the search were: (1) *physical activity* or *physical fitness* or *motor activity* or *exercise* or *physical education* or *behavior change* (2) AND *internet* or *website* or *world wide web* or *web-based* or *internet-based*; (3) AND *chronic disease* or *chronic illness* or *chronic condition*; (4) AND *intervention* or *study* or *randomized controlled trial* or *clinical controlled trial*". The search strategy was formulated in PubMed and adapted for use in other databases. In addition, we hand-searched the

reference lists of included studies and other systematic reviews [5;16;22-26;35-38] for potential relevant articles.

In- and exclusion criteria

Types of studies
Included studies were randomized controlled trials (RCT) or controlled clinical trials (CCT) published in the English or Dutch language.

Types of participants
Participants older than 18 years with a chronic disease according to the International Classification of Diseases (ICD-10) were included. A chronic disease is defined as 'disease of long duration and generally slow progression'. Common chronic disorders include diabetes mellitus, ischemic heart disease, chronic obstructive pulmonary disease and arthritis. According to current guidelines, obesity (BMI greater than or equal to 30 kg/m2) was considered a chronic disease [39]. Studies focusing on chronic mental illnesses were excluded.

Types of interventions
In this study, we used the classification of Barak et al. [16] for the selection of web-based interventions. Eligible web-based interventions were classified as self-guided programs operated through a website to realize PA behavior change. In addition, studies focusing on other behavioral change components (e.g. weight reduction or dietary habits) other than PA were also included. Self-guided interventions incorporate minimal human support. Generally, this means that the content is presented in a highly structured format with automatic functions (e.g. automatic text messages, automatic e-mail and non-interactive video) without human support. Studies were excluded if interventions comprised direct human contact (e.g. through online counseling, chat or interactive video communication). Although studies with additional treatments arms were included (e.g. face-to-face sessions), only the effects of minimum human interventions were analyzed.

Types of control interventions
Only studies in which web-based PA programs were compared with no or minimal treatments were included.

Types of outcome measures
Only studies with the outcome measure PA were included. There are several subjective (e.g. questionnaires, PA diary) and objective methods (e.g. accelerometer, pedometer) in measuring PA. All PA measures, either objective or subjective, were included.

Procedure of inclusion
The procedure of inclusion of studies was based on the recommendations as described by Tulder et al. [40]. This procedure consisted of two stages. First, titles and abstracts were screened independently by two reviewers (DB and CV). Studies were excluded if the title and/or abstract did not meet the inclusion criteria. Second, full text articles were reviewed by the same 2 reviewers and studies were excluded if the content did not meet the inclusion criteria. Subsequently, disagreements regarding article inclusion were resolved with discussion and consensus between the 2 reviewers.

Assessment of methodological quality
The methodological quality of all articles was independently assessed by two reviewers (DB and CV) using a criteria list [40], as recommended by the Cochrane collaboration back review group (Table 1). Several systematic reviews in the area of PA and exercise therapy have used this list [e.g.22;41]. The list of Van Tulder et al. [40] contains an 11-point scoring system related to selection bias (3 criteria), performance bias (4 criteria), attrition bias (2 criteria) and detection bias (2 criteria). One performance bias criteria, "care provider blinded", was not considered appropriate for web-based interventions and was omitted from the criteria list. All items from the list (10 items) were scored as "yes" (1 point), "no" (0 points) or "unclear" (0 points). Studies with a score of $\geq$6 out of 10 were judged to be of high quality. Disagreements about the methodological quality between the 2 reviewers were resolved by discussion and consensus.

Table 1: Criteria List for Assessment of Methodological Quality

Validity criteria		yes	no	don't know
A	Was the method of randomization adequate?	☐	☐	☐
B	Was the treatment allocation concealed?	☐	☐	☐
C	Were the groups similar at baseline regarding the most important prognostic indicators?	☐	☐	☐
D	Was the patient blinded to the intervention?	☐	☐	☐
E	Was the care provider blinded to the intervention?*	☐	☐	☐
F	Was the outcome assessor blinded to the intervention?	☐	☐	☐
G	Were co interventions avoided or similar?	☐	☐	☐
H	Was the compliance acceptable in all groups? (<6 months studies 20%, >6 months studies 30%)	☐	☐	☐
I	Was the dropout rate described and acceptable?	☐	☐	☐
J	Was the timing of the outcome assessment in all groups similar	☐	☐	☐
K	Did the analysis include an intention-to-treat analysis?	☐	☐	☐

☐ High quality; the study adequate fulfilled 6 or more out of 10 criteria
☐ Low quality; the study fulfilled less than 6 out of 10 criteria

Note: * excluded in this review

Data analysis

Data was extracted by using a predefined data extraction form, with study characteristics (type study, year of publication), patient's characteristics (number, age, gender and chronic disease), intervention characteristics (duration, theoretical foundations, description of contents) and pre- and posttest PA outcomes. Wherever possible, we calculated effect sizes for papers in which no effect size was reported. Furthermore, according to Hoehner et al [58], the net effect for all PA measurements was calculated as relative percent change from baseline. Clinical heterogeneity was assessed by inspecting the type of participants, interventions and outcomes of each study. Owing to the considerable variety of PA measurements, type of PA outcomes, follow-up periods and intervention duration, results could not be reliably combined. Therefore we decided to perform a qualitative systematic

review instead of a meta-analysis. A best evidence synthesis was performed based on five levels of evidence [40] (see table 2). In this strategy, conclusions are based on consistency of results and the methodological quality of the original studies. *Strong* (multiple high quality trials) *moderate* (low quality trials and/or one high quality trial) and *limited* (at least one low quality trial) evidence is detected if more than 75% of the studies find results in the same direction. Findings are considered *conflicting* if studies report inconsistent results and *no evidence* is defined if there are no randomized trials available.

Table 2: Best evidence synthesis

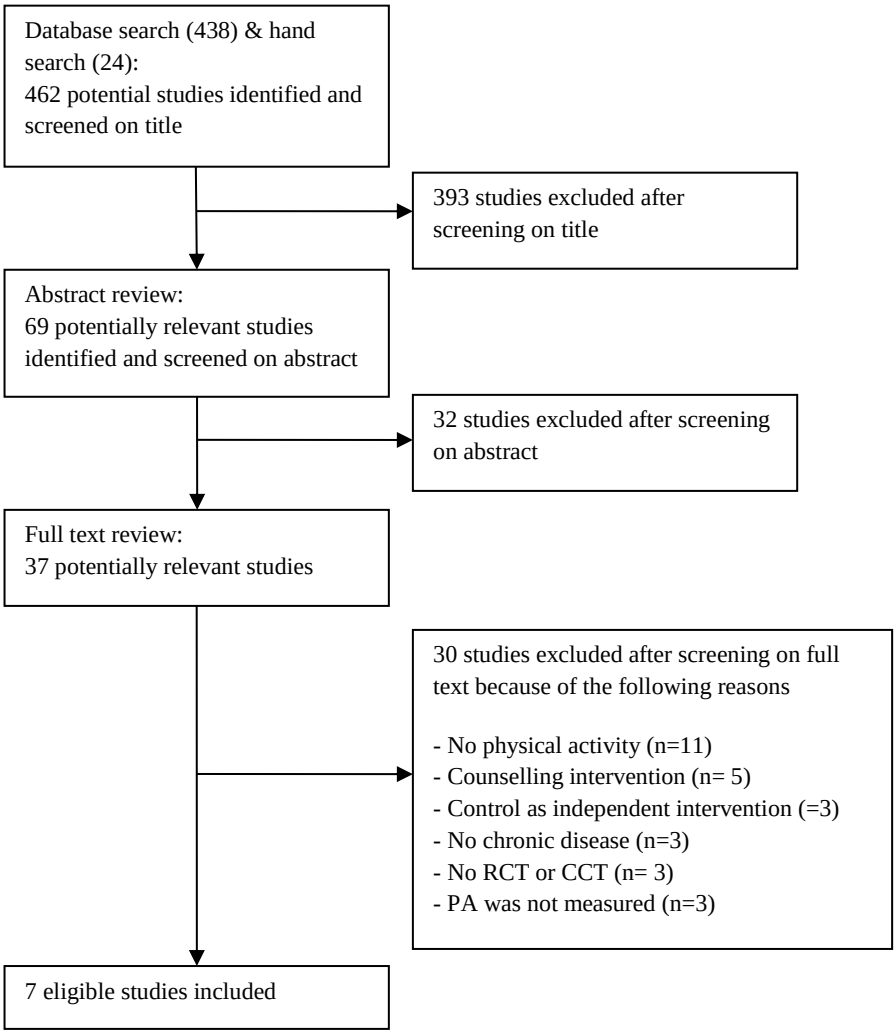
Strong evidence	Consistent findings in multiple high quality trials
Moderate evidence	Consistent findings in multiple low quality trials and/or one high quality trial
Limited evidence	Consistent findings in outcome measures in at least one low quality trial
Conflicting	Inconsistent findings among multiple trials
No evidence	No randomized trials available

Results

Selection of studies

The flowchart in Figure 1 gives an overview of the selection procedure. The database (438) and hand search (24) yielded 462 citations. Subsequently, 455 publications were eliminated based on title, abstract and full text. Ultimately, seven articles fulfilled the inclusion criteria and were included in this review.

Figure 1: overview of the selection procedure



Methodological quality

Initially, there was disagreement between the reviewers about methodological quality scores in 12 of the 70 (7 X 10) items. After using the consensus method, no disagreement persisted. Table 3 presents the methodological quality of the included studies. Of the seven studies selected for inclusion, five studies were graded as high methodological quality [42-46] and two were graded as low quality [47;48]. Considering that concealment in web-based intervention studies is not possible, none of the studies met the 'blinding of patients' criteria. Several studies revealed incomplete information about 'adequate randomization' [42;46;47] 'concealment of treatment allocation' [42-44;47;48], 'blinding of outcome assessment' [43-45;47]' and 'co-interventions avoided or similar' [43-45;47].

Table 3: Methodological quality assessment

	Fulfilled validity criteria				Unfulfilled validity criteria	Incomplete information for validity assessment	Internal validity score	Methodological quality
	Selection bias (a, b, c)	Performance bias (d,g,h)	Attrition bias (i and k)	Detection bias (f and j)				
Bosak, 2010	C	G,H	I,K	F,J	D	A,B	7	High
Glasgow, 2010	A,C	H	I,K	J	D	B,F,G	6	High
Kosma, 2005	C	-	-	J	D,H,I	A,B,F,G,K	2	Low
McConnon, 2007	A,C	G	K	J	D,F,H,I	B	5	Low
McKay, 2001	A,C	H	I,K	J	D	B,F,G	6	High
Motl, 2010	A,B,C	H	I,K	J	D	F,G	7	High
Tomita, 2009	C	G,H	I,K	F,J	D	A,B	7	High

Characteristics of selected studies

Study characteristics are presented in Table 4. All studies were published between 2001 and 2010. Of the seven selected studies, six were performed in the United States [42-47] and one in United Kingdom [48]. Five studies were randomized controlled trials [42;43;45;46;48] and two studies were randomized controlled pilot studies [44;47]. Five studies had a two-arm design [42;44-46;48], while two studies had a three-arm design [43;47] in which two groups received a different treatment. Regarding the three-arm studies, distinction between the two investigated interventions was the amount of personalized contact between participant and health care provider. A significant number of studies defined eligibility criteria regarding age, baseline PA level, type of disease and contraindications for PA. Table 5 gives an overview of the selected outcome measures. In all studies, PA behavior was reported as an outcome measure. Although one study applied a combination of subjective and objective measurements [42], the majority of studies used only self-reported PA questionnaires [43-48]. Included interventions used a variety of PA outcome measures, such as moderate PA, walking, leisure time PA and PA caloric expenditure. With regard to all included studies, interventions were compared with no (waiting list controls) or minimal (attention controls) treatment.

Characteristics of study populations

Table 4 shows that the number of participants across the studies ranged from 22 to 463. The majority of participants were female; the percentage of male participants varied between 10% to 72.2%. The mean age in the sample fluctuated between 38.7 and 76.2 years. The study population consisted of patients with various disorders, including multiple sclerosis [45], diabetes mellitus 2 [43;44], metabolic syndrome [42], physical disabilities [47], heart failure [46] and obesity [48]. Four of the seven studies were addressed to sedentary patients at baseline [43-45;47]. The percentage of completes from enrolment to the final follow up varied between 49.6% [47] and 89% [45].

Characteristics of the interventions

Table 4 illustrates the characteristics of the web-based interventions. The results show that duration of the intervention varied from one month to twelve months. Four interventions intervened on PA only [42;44;45;47] and three interventions addressed additional health behavior components [43;46;48], such as dietary behavior and medication adherence. Included studies were either self-directed or had minimal contact with experts and/or health professionals. Three interventions used additional delivery components [44;46;48], other than a website. These components contained automatic generated e-mails or non-interactive videos. Of the seven described interventions, five were theory-driven [43-47]. In two studies, interventions were developed according to the transtheoretical model [46;47]. Other interventions were based on the social cognitive theory, '5 As' self-management model [43] and social ecological theory [43;44]. Among the studies, the length of follow up varied widely from one month [47] to 12 months [48].

Table 4: Characteristics of studies, participants and interventions

Author, year of publication	Study	In- & exclusion criteria	Study pop. (no. of patients mean age, % male)	Dropout number and rate % from enrolment to final follow-up	Intervention (content, used theory and targeted health behavior)	Duration intervention	Control
Bosak, 2010, USA	RCT	Patients (≥ 19 years) with a metabolic syndrome who were able to ambulate independently without CVD symptoms.	N=22 Age: 50.9 (7.9) Male: 72.7%	19 (86) completers GD:?	A web-based intervention to enhance self-efficacy to overcome barriers. In addition, participants received one consult with physician and dietician. The intervention is not based on a theory and was focused on PA only.	6 weeks	One consult with physician and dietician.
Glasgow, 2010, USA	RCT	Sedentary overweight type 2 diabetic patients (25-75 years) with one additional risk factor for cardiovascular disease (CVD).	N=463 Age: 58.4 (9.2) Male:50.2%	375 (80.1) completers I: 260(78.5) C:115 (87.1)	A web-based program with goal setting. action plans and problem-solving. The intervention is based on '5 As' self-management model[57] and social ecological theory [58] targeting medication adherence, exercise and food choices.	4 months	General information on a website
Kosma, 2005, USA	RCP	Sedentary adults (18-54 years) with physical disabilities without contraindications for PA.	N=151 Age: 38.7 (8.9) Male: 28%	75 (49.6) completers I: 46 (45.5) C: 29 (58)	Web-based PA motivational program with weekly new content. The intervention is based on the TTM theory and focusing on PA only.	1 month	Attention control group
McConnon, 2007, UK	RCT	Obese patients (18-65 years) with a BMI≥30.	N=221 Age: 45.8 (10.6) Male:23%	131 (59.3) completers I: 54 (48.6) C: 77 (70)	Online advise. tools and information for behavior change with additional tailored automatic generic e-mails regarding eating and PA habits. The intervention concerns no particular theory and is focused on dietary and PA behavior patterns.	1 year	General information on printed materials.
McKay, 2001, USA	RPS	Sedentary type 2 diabetic patients (≥40 years) without contraindications for PA.	N=78 Age52.3 (?) Male:47%	68 (87.2) completers I: 35 (92.1) C:33 (82.5)	A personalized PA website with 5 steps action plan and additional support provided by a personal coach by means of 4 e-mails. The intervention is based on the multilevel social-ecological model of diabetes self-management and was focused on PA only.	8 weeks	Internet information only
Motl, 2010, USA	RCT	Sedentary patients with relapsing-remitting multiple sclerosis without contraindications for PA.	N= 54 Age: 48.9 (10.1) Male: 10%	48 (89) completers I: 23 (85) C:25 (93)	The content of the internet intervention consists of 4 modules: getting started. planning. beating odds and maintenance. Intervention is based on SCT targeting PA only.	3 months	Attention control group
Tomita, 2009, USA	RCT	Patients (≥60 years) with a history of heart failure living at home	N=40 Age: 76.2 (8.6) Male:32.5%	32 (80) completers I:16 (81.2) C:24 (79.2)	A web-based self-management intervention with information support and exercise instruction program delivered via video (not interactive). In addition participants received monthly an e-mail with appraisal support. The intervention is based on the TTM focusing on several health behaviors including PA.	1 year	Three-month check up by a physician

RCT, Randomized Controlled Trial; RCP, Randomized Controlled Pilot study; PA, PA; TTM, Trans-Theoretical Model; SCT, Social Cognitive Theory; ?, unknown; GD, group differences.

Effectiveness of interventions

Table 5 describes a variety of outcome measures and results from the selected studies. PA pre-and post-test scores are presented for both intervention and control groups. A best evidence synthesis was performed to summarize the effectiveness of web-based PA interventions. Three high quality studies showed significant improvements in PA in favor of the intervention group [43;45;46]. Two high quality trials reported non-significant differences in PA scores between intervention and control group [42;44] and two low quality studies also reported non-significant differences between groups [47;48]. Effect sizes ranged from 0.13 [42] to 0.56 [45]. There is conflicting evidence whether web-based PA interventions are effective in patients with a chronic disease. As shown in Figure 2, the net effect sizes ranged from –5% of minutes a day spent on walking to 185% of meeting 2-3 exercise a week.

Figure 2: Net percentage change in physical activity

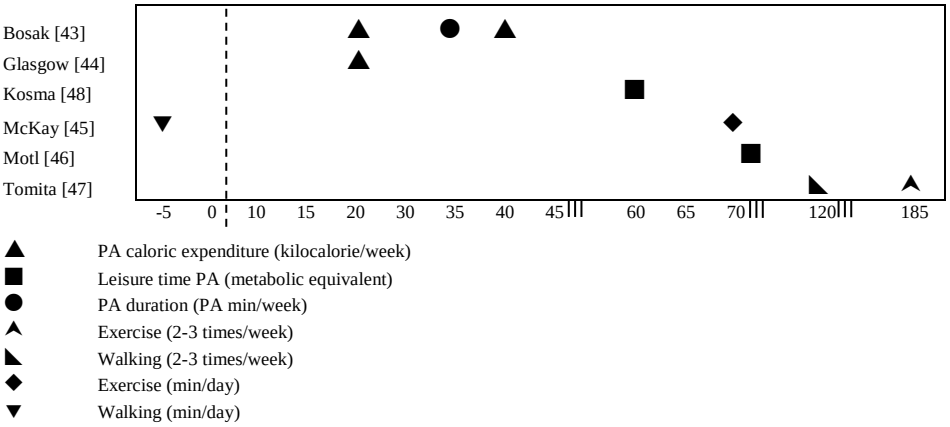


Table 5: PA outcome measures and pre- and post-test results

Author, year, country and study population	Meth. quality	Follow-up	PA outcome measures				Effect sizes	Conclusion
			PA measurements	Type of PA outcome variable	PA pre-test mean ± SD	PA post-test mean ± SD		
Bosak, 2010, USA, N=22	High	0,6 weeks	7-day PA recall via phone interview + RT3 accelerometer	PA duration and PA calorie expenditure	Change of PA min/week: I: 72.9 (±38.7) C: 74.7 (±25.6)	Change of PA min/week: I: 83.7 (±33.1) C: 60 (±34.1)	0.15	No significant differences between groups.
					Change in PA kcal/week I: 461.6 (±258.6) C 387.8 (±74.4)	Change in PA kcal/week I: 487.3 (±287.2) C:330.8 (±193)	0.13	
					Change in PA kcal/week I: 653 (±806.5) C:632.9 (±151.4)	Change in PA kcal/week I:800.2 (±706.9) C: 530.4 (±337.4)	0.02	
Glasgow, 2010, USA, N=463	High	0,4 months	The community health activities model program for seniors questionnaire	PA caloric expenditure	Total kcal/week I:3981±3019 C:3979±3292	Total kcal/week I:3923±3431 C:3241±3221	0.19	Significant differences between groups.
Kosma, 2005, USA, N=151	Low	0,1 month	13 item PA scale for individuals with physical disabilities	Leisure time PA	MET hours/day I: 6.1 (±7.4) C:9.3 (±7.7)	MET hours/day I: 8.2 (±6.8) C: 6.9 (±7.8)	0.34	No significant differences between groups.
McConnon, 2007, UK, N=221	Low	0,12 months	Baecke PA questionnaire	Work, leisure and sports activity	Points questionnaire I:6.8 (0.98) C:6.7 (1.3)	Points questionnaire I: ? C:?	?	No significant differences between groups.
McKay, 2001, USA, N=78	High	0,8 weeks	11 items from the BRFSS	Moderate-to-vigorous exercise and walking	Exercise (min/day) I: 5.6 (±6.2) C:7.3 (±6.2) Walking (min/day) I:6.4 (±6.2) C:8.4 (±8.4)	Exercise (min/day) I: 17.6 (±15.3) C:18.0 (±17.3) Walking (min/day) I:12.5 (±9.5) C:16.8 (±22.8)	0.11 0.14	No significant differences between groups.
Motl, 2010, USA, N=54	High	0,3 months	Godin leisure time exercise questionnaire	Leisure time PA	(MET min/week) I: 13.8 ± 15.2 C:11.7 ± 16.3	(MET min/week) I: 24.7 ±18.8 C:12.4 ± 14.2	0.56	Significant differences between groups.
Tomita, 2009, USA, N=40	High	0,12 weeks	Nominal scale for PA and exercise frequency	Exercise and walking	Walking (2-3 times/week) I: 55% C: 65% Mild exercise (2-3 times/week) I:22% C:18%	Walking (2-3 times/week) I:100% C:42% Mild exercise (2-3 times/week) I:54% C:11%	?	Significant differences between groups.

PA, PA; I, intervention group; C, control group; Kcal, Kilocalorie; MET, Metabolic equivalent; BRFSS, behavioral Risk Factor Surveillance System; ?, unknown

Discussion

The current systematic review aimed to summarize the effectiveness of web-based PA interventions targeting patients with a chronic condition. The best evidence synthesis revealed conflicting results with regard to the effectiveness of web-based PA interventions in patients with a chronic disease. Although no conclusive evidence was found, a trend toward positive effects was identified in favor of the intervention groups. Three high quality studies [43;45;46] reported significant effect sizes and two high [42;44] and two low quality studies [47;48] did not reach statistical significance. Two studies [45;47] reported medium effect sizes (E.S= >0.3 and <0.5), while three other studies [42-44] presented small effect sizes (E.S= <0.2).

In the present review we found only seven eligible studies which met our inclusion criteria. Along with the limited number of studies, sample sizes tended to be small which reduced the statistical power in our review. Three out of seven studies [42;45;46] included fewer than 60 participants. Recognizing the lack of power, effect sizes were considered to gain insight into trends in the data. It is expected that with larger samples sizes, more between group comparisons would be statically significant. Another factor that may have contributed to the conflicting evidence are the dropout rates in the individual studies. To illustrate, two large-sample-size studies with high drop-out rates (>50%) reported non-significant findings, while two smaller studies with low drop-out rates (<20%) yielded significant results. This review found, in line with others [25;49;50], substantial dropout rates (25.2%). Intervention groups suffered slightly more from dropout than the comparison group (27.2% vs 24.1%). Since the success of web-based interventions requires active participation, high dropout rates have been pointed out as a common concern in the field of web-based education [49;51]. A factor that may have exacerbated dropout rates in our review is the patient characteristics, namely the sedentary participants diagnosed with a chronic disease. Research has indicated that a chronic condition and inactivity decrease the odds of using web-based interventions [32;52]. Apparently, web-based interventions fail to reach those whom PA behavior changes are most necessary. Another explanation for the high dropout may

be that the intervention content was based on self-directed features with minimum personal contact. Research has suggested that therapeutic involvement may enhance participant engagement [51;53]. Obviously, the low level of personal contact may have negatively impacted dropout rates because participants are less motivated and feel less obliged to continue. The use of certain 'push factors', including automatic e-mails, periodic prompts, self-monitoring, peer support and provision of feedback may enhance website usage [51]. Further insights are needed to investigate which of those incentives keep participants engaged and which characteristics (e.g. pain, fatigue or reduced physical performance capacity) are related to dropout.

With regard to the methodological quality, five studies were rated as high and two studies were classified as low quality. Six out of seven articles were published after 2005. These numbers illustrate the increase use of web-based education in patients over recent years. Although interventions were mostly theory driven to maintain increased levels of PA, the majority of studies failed to report long term post intervention follow-up. Only one study [48] demonstrated intervention effects after one year. Therefore, future studies require a longer duration of follow up (>1 year).

With respect to the measurements, most studies used self-reported questionnaires. This, however, is in contrast to prior recommendations because questionnaires may lead to recall error, perceived social desirability and other biases [54]. Subjective measurements tend to overestimate true levels of PA, increase the variance in outcome measures and subsequently lead to an attenuation of effectiveness. Future research should preferably combine subjective and objective PA measurements. Despite limited evidence, observed results do not automatically imply clinical irrelevance. Contrarily, with respect to other behavior change approaches, web-based behavior programs have the unique potential to reach large populations. Considering the size of the populations, even small effects may have large public health consequences. Research has shown that even small PA effects can lead to important health benefits. Improvement in PA appears, particular in older and at risk populations, to be important to maintain functional

independence [55]. This provides support for more development and extensive implementation.

To our knowledge, this literature study differs from previous systematic reviews [22-26] in the following ways. Firstly, to enhance clinical validity, this review focused on self-help programs delivered through websites. Whereas previous reviews focused on internet interventions combined with therapeutic (online) counseling, we focused exclusively on self-help interventions with minimum therapeutic involvement. Secondly, included interventions were mainly developed to reinforce PA. Thirdly, in order to avoid heterogeneity of exposure among participants in the control group, content of the control groups concerned none or minimal treatment. Lastly, while other reviews included predominantly healthy persons, we focused solely on chronically ill patients.

Limitations of this study

This review was limited by the small number of studies and heterogeneity in outcome measures and follow-up time. Therefore, we decided to conduct a best evidence synthesis. A best evidence synthesis is less sensitive than meta-analysis. Another limitation is that three included studies [43;46;48] evaluated a multicomponent intervention (e.g., a combination of physical activity and nutrition). Therefore it is hard to determine with certainty whether the PA components were the actual determinants of the PA behavior change. Furthermore, we only considered English and Dutch language studies and excluded dissertations and other grey literature. Therefore, it is possible that this review is not a complete representation of all available evidence.

Implications for future research

Although a trend toward positive effects was identified in favor of the intervention groups, our best evidence synthesis revealed that there is conflicting evidence on the effectiveness of web-based PA interventions in patients with a chronic disease. Studies in this review suffered from high drop-out and nonusage rates. Eysenbach calls this phenomenon “The law of attrition” [51]. Therefore, it is advised that future interventions integrate

more push factors (e.g. automatic emails, weekly new content, short text messages) to improve study and program compliance. Website interventions to promote PA among chronically ill are still in the preliminary stages of development. There is a need for more published studies in this research area. Based upon this review, future research should (1) design more interventions specifically for patients with a chronic disease and low PA level; (2) explore which components reinforce adherence to web-based PA interventions; (3) use objective measures of PA, and (4) and incorporate larger sample sizes to achieve sufficient statistical power. Moreover, future studies need to reach consensus on PA measures and should use a combination of validated questionnaires with objective measures to obtain the best results. Lastly, although not investigated in this review, issues related to access and disparities need to be better understood. Automated self-help intervention may contribute, in technical sense, to a reduction of health disparities worldwide. However, in practice, health education through internet is predominantly used by well-educated and informed people who are already privileged in terms of health and healthcare utilization [55]. Therefore, more research is needed to reach those who need most care.

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3

The usability and preliminary effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis

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Abstract

Background A large proportion of patients with knee and/or hip osteoarthritis (OA) do not meet the recommended levels of physical activity (PA). Therefore, we developed a web-based intervention that provides a tailored PA program for patients with knee and/or hip OA, entitled Join2move. The intervention incorporates core principles of the behaviour graded activity theory (BGA). The aim of this study was to investigate the preliminary effectiveness, feasibility and acceptability of Join2move in patients with knee and/or hip OA.

Methods A non-randomized pilot study was performed among patients with knee and/or hip OA. Primary outcomes were PA (SQUASH Questionnaire), physical function (HOOS and KOOS questionnaires) and self-perceived effect (7-point Likert scale). Baseline, 6 and 12 week follow-up data were collected via online questionnaires. To assess feasibility and acceptability, program usage (modules completed) and user satisfaction (SUS questionnaire) were measured as secondary outcomes. Participants from the pilot study were invited to be interviewed. The interviews focused on users' experiences with Join2move. Besides the pilot study we performed two usability tests to determine the feasibility and acceptability of Join2move. In the first usability test, software experts evaluated the website from a list of usability concepts. In the second test, users were asked to verbalize thoughts during the execution of multiple tasks.

Results Twenty OA patients with knee and/or hip OA between 50 and 80 years of age participated in the pilot study. After six weeks, pain scores increased from 5.3 to 6.6 ($p=0.04$). After 12 weeks this difference disappeared ($p=0.5$). Overall, users were enthusiastic about Join2move. In particular, performing exercise at one's own pace without time or travel restrictions was cited as convenient. However, some minor flaws were observed. Users perceived some difficulties in completing the entire introduction module and rated the inability to edit and undo actions as annoying.

Conclusions This paper outlines the preliminary effectiveness, feasibility and acceptability of a web-based PA intervention. Preliminary results from the pilot study revealed that PA scores increased, although differences were not statistically significant. Interviews and usability tests suggest that the intervention is feasible and acceptable in promoting PA in patients with knee and/or hip OA. The intervention was easy to use and the satisfaction with the program was high.

Trial registration The Netherlands National Trial Register. Trial number: NTR2483

Background

Osteoarthritis (OA) in the knee and hip is a degenerative joint disorder with a high prevalence that increases with age. The disease is associated with pain, functional disability and impaired quality of life [1,2]. OA is considered one of the major disabling diseases in the western world, affecting 10% of men and 18% of women over the age of 60 [3]. It has been recognized that regular physical activity (PA) is an effective lifestyle strategy in the management of OA [4-6]. However, to date the vast majority of OA patients remain sedentary [7-9]. In the long term, physical inactivity may lead to functional decline [10,11]. To maintain and improve physical function, the promotion of PA is a cornerstone in the treatment of OA [12].

Since general practitioners (GP) are considered the first and main point of contact for people with OA, the general practice is ideally situated to promote PA. In practice, however, a GP's ability to encourage physical exercise is limited by time constraints and lack of standard protocols [13,14]. In particular, core elements concerning the risks of sedentary behaviour are insufficiently emphasized. At the same time it is unlikely that OA patients will receive help elsewhere, since 90% are not referred to other health care professionals such as a physical therapist, orthopedic doctor, rheumatologist or rheumatology trained nurse [15]. In this study, we call this group 'outside-care patients' and define them as those patients who did not have 'face-to-face' contact with a health care provider, other than a GP, for OA in the last six months.

The World Wide Web provides an alternative medium for reaching outside care patients. In Europe 61% and in North America 79% of the population have internet access [16]. Although the rate is lower in younger age groups [17], recent trends show that older people are among the fastest-growing internet users. To illustrate, in the Netherlands 95% of adults (55–65 years) and 75% of older adults (65–75 years) have access to internet in their home [18]. The internet is convenient, anonymous and appealing for those who want to work in their own environment and in their own time [19]. In particular, web-based interventions without the involvement of professionals

have the potential to reach large populations, with a minimal burden on scarce health resources [20]. In recent years, several reviews reported that web-based interventions can be effective in promoting PA. Internet programs for patients with diabetes [21], multiple sclerosis [22] and heart failure [23] have led to the improvement of PA outcomes, even though effect sizes are small. Considering the potential of high reach and low costs [19], even these small effect sizes have large public health consequences. Given the advantages of the internet and its unique ability to reach outside care OA patients, we developed Join2move. Over the course of one year, we used an iterative design methodology to test, analyze and refine the Join2move program. As part of the iterative development process, this paper focuses on the preliminary effectiveness and the usability of Join2move.

Join2move

Development was based on a systematic review [24] and a previously developed Behavioral Graded Activity (BGA) intervention [25]. The framework of the BGA program incorporates a baseline test, goal setting, time-contingent PA objectives (i.e. on fixed time points) and text messages to promote PA. An essential feature of the BGA program is the positive reinforcement of gradual PA, despite the presence of pain. The gradual increase in activities changes the perception that PA is related to pain and reinforces confidence to improve PA performance. This may lead to positive physical (e.g. physical capacity, muscle strength and joint mobility) and psychological changes (e.g. self-esteem, pain perception and anxiety). Due to the highly structured format of the BGA intervention, the internet constitutes a promising platform for translating BGA into a self-help format. The Join2move intervention is a fully-automated web-based intervention which contains automatic functions (automatic text messaging and automatic e-mails) without human support. Participants are initially presented with the homepage http://www.artroseinbeweging.nl. The password-secured PA program is available 24/7 from the homepage and is provided without charge. In keeping with the BGA treatment, the Join2move intervention is a self-paced nine week PA program in which patients' favorite recreational activity is gradually increased in a time-contingent way. In the first week of the program, users select a central activity (e.g. cycling, walking or

gardening), perform a 3-day self-test and determine a short term goal for the next eight weeks. Based on test performances and a short term goal, eight tailored weekly modules are automatically generated. Every week, new weekly assignments and evaluation forms (pain and performance) are posted on the password-secured website. If a scheduled weekly module is missed, users can choose to repeat the module, adapt the difficulty or continue with the next module. Since personal messages are updated on a weekly basis, users are encouraged to log in once a week. Automatic e-mails are generated if participants do not visit the website regularly. A description of the intervention is provided in Table 1.

Table 1: Description of the Join2move intervention

1. Filling out a PA Readiness Questionnaire (PARQ)	If participants answered "YES" to any of the seven PARQ, they were advised to see their GP before participation. If patients answered 'NO' to all of the questions, it was considered safe for them to engage in Join2move.
2. Provision of educational messages	Core elements of the program are presented on the personal website, including 1) focus on improving physical function rather than pain reduction; 2) first weeks can be accompanied by more pain;3) participant shares responsibility and has an active role.
3. Selection of a central PA	A favourite and a problematic activity are selected from an activity list, including walking, cycling, swimming etc.
4. Determination of baseline value via a 3-day self-test	To determine the baseline value, participants were requested to perform the selected activity three times a week until the pain threshold was reached. PA performances (minutes) and pain scores (1 to 10) were recorded in an online diary and stored on the website.
5. Setting a short and long term goal	In accordance with the baseline values, a range of goals is generated and presented on the website. Between the lower and upper limit of goals, patients could select a short term goal (9 weeks). Furthermore, a long term goal was set for 1 year.
6. Signing an agreement form	Participants sign an online agreement form. This form presents the short term goal and, again, core elements of the program.
7. Gradually increase selected activity (8 weekly modules)	Based on the short term goal, a tailored schedule of eight weekly modules is made on a time-contingent basis (i.e. fixed time points). The start of the schedule is slightly below the baseline value and increases incrementally towards the short term goal. Patients should not under-perform or over-perform this gradually increasing schedule. Every week, new modules and evaluation forms (pain and performance) are posted.

GP, general practitioner; PA, physical activity

Objectives

Extensive exploration is needed in order to examine the potential of the Join2move program. Consequently, our research question was:“ What is the preliminary effectiveness (PA, physical function and self-perceived effect), feasibility and acceptability of Join2move in patients with knee and/or hip OA?” “Feasibility” concerns whether we are capable of carrying out Join2move in a larger study. “Acceptability” is whether participants support or reject Join2move.

Methods

Pilot study

Study design and objective
This pilot study used a non-randomized design. Our primary focus was to determine the preliminary effectiveness of the Join2move intervention. A second purpose was to determine program use and user satisfaction with the Join2move intervention. This pilot study, which aimed to provide a basis for a large Randomized Controlled Trial (RCT), was part of a research protocol which has been approved by the ethics committee of the VU University Medical Center Amsterdam (Dutch Trial Register NTR2483).

Participants
Patients with self-reported knee and/or hip OA were recruited through advertisements in Dutch newspapers and online health-related websites. Eligibility criteria were 1) age 50–80; 2) self-reported OA in knee and/or hip; and 3) no physical therapy and/or treatment from a medical specialist for OA in the last six months. Potential participants were excluded if they 1) had no internet access at home, 2) were unable to understand the Dutch language and 3) had contra-indications (loss of consciousness and cardiovascular disease) for PA without medical supervision. To verify self-reported diagnosis, we performed clinical tests to assess the presence of knee and/or hip OA. Assessments were performed by a physiotherapist after the

study period, according to the American College of Rheumatology (ACR) [26,27].

Procedure and measures

Interested patients who met the inclusion criteria were sent an invitation letter requesting informed consent. Once written informed consent was obtained, participants were invited to fill out a baseline questionnaire. After the baseline assessment, participants were assigned to the intervention. We conducted two online post-tests at 6 and 12 weeks after baseline.

Preliminary effectiveness

To assess the potential effectiveness of the Join2move intervention, primary outcome measures in this study were PA, physical function and self-perceived effect. Secondary outcomes were OA symptoms, sport and recreation and quality of life. The first primary outcome, self-reported PA, was measured by the Short Questionnaire to Assess Health-enhancing PA (SQUASH) [28]. Pain scores and physical function were determined through a 10- point Likert scale as well as the subscale pain of The Knee Osteoarthritis Outcome Score (KOOS) [29,30] and the Hip Injury Osteoarthritis Outcome Score (HOOS) [31,32]. The three secondary outcomes, symptoms, sport and recreation activity and quality of life, were also collected by using the HOOS and KOOS questionnaire. Descriptive statistics were used to analyse the data. Paired sample t-tests and regression analysis were used to determine the significance of the differences.

Feasibility and acceptability

To assess the feasibility and acceptability of the intervention, program usage and user satisfaction were measured as secondary outcomes. Program usage was measured by the number of weekly modules completed. Once a participant read the weekly assignments and filled out the evaluation form, the module was defined as completed. Adequate exposure to the program was achieved if users interacted at least 75% with the program content. This cut-off point was determined by the research team on the basis of previous research [33]. User satisfaction was measured via the System Usability Scale (SUS) [34]. Besides the usage and satisfaction, patients from the pilot study

were invited for interviews to test user experiences. Semi-structured interviews were audio-recorded and transcribed with the interviewee's permission. An interview guide with open questions was employed to provide structure to the interviews. Transcribed texts were read and discussed to gain an overall understanding of the usability and user satisfaction.

Usability tests

Participants

Two qualitative tests were performed to determine the usability of the Join2move intervention, viz.,1) heuristic evaluation, and 2) the Thinking Aloud approach. For the heuristic evaluation, four software experts from Netherlands Institute for Health Services Research (NIVEL) were invited to participate. With respect to the Thinking Aloud approach, five patients between the ages of 50–80 years with self-reported knee and/or hip OA were recruited via the Dutch Arthritis Foundation. The sample size for the Thinking Aloud approach was based on previous research by Nielsen [35]. The author claims that five users are enough to catch 85% of the usability problems.

Procedures and measures

The first usability test, the heuristic evaluation, was performed by means of a set of usability criteria created by Jakob Nielsen [36] and Dana Chisnell [37]. Nielsen [38] described heuristic evaluation as an informal method of usability testing that consists of a number of evaluators who are presented with an interface design and are then asked to comment on the errors and effectiveness of the product. Heuristics includes concepts such as “Does the system behave consistently?”, “Does the site use words that older adults know?”, “Is the program perceived as helpful?”(see Appendix 1 for the full list of heuristics). Software experts individually evaluated the website, based on the list of heuristics. Subsequent discussion yielded a list of usability issues. The second instrument, the Thinking Aloud approach [39], was used to consider how end-users interact with the intervention. In a home-based setting, test subjects were encouraged to verbalize their thoughts during the

execution of multiple tasks. These tasks represented the major functionality of the intervention. Evaluations were carried out by two moderators. The procedure was video-recorded and transcribed afterwards.

Results

Pilot study

Participants

Of the 47 registered patients, fifteen (32%) did not meet the inclusion criteria. Reasons for exclusion were: no OA symptoms (n=3); receiving treatment from a physical therapist for OA (n=2); OA in other joints than knee or hip (n=7); and not meeting the age criteria of 50–80 years (n=3). Furthermore, seven (15%) participants did not return the informed consent document and five (11%) participants withdrew after returning informed consent. A total of twenty (42%) participants were finally included. Sixteen (80%) participants agreed to be interviewed. According to the ACR criteria, thirteen of the sixteen participants (81%) had clinical knee and/or hip OA, and three participants (19%) had no OA. Participants' demographic characteristics are shown in Table 2.

Table 2: Demographic and clinical characteristics

Participants (N%)		
Gender		
Male	5	25
Female	15	75
Age (years, SD)	64	6.6
Location OA		
Knee	7	35
Hip	5	25
Knee and hip	8	40
Duration OA symptoms (years, SD)	9.3	11.4

OA, osteoarthritis; SD, standard deviation.

Preliminary effectiveness

PA results at baseline, six weeks and twelve weeks are given in Table 3. Over the twelve week period, the total time spent on PA increased from 1,697 to 2,044 min/week, and the time spent on moderate intensity increased from 323 to 553 minutes a week. These results, did not however, attain statistical significance (p=0.3 and p=0.43, respectively). At 6 weeks, patients did report significantly higher levels of pain compared to the baseline - from 5.3 to 6.6 (p=0.04). After twelve weeks the differences were no longer statistically significant (p=0.5). With regard to physical function, a small, non-significant increase was observed (Table 4).

Table 3: Comparison of change in PA levels (mean and SD)

PA (mean, SD)	Baseline (n=20)	6 weeks (n=20)	12 week (n=15)
Total PA (min)	1697 (1174)	2108 (1206)	2044 (1369)
Moderate PA (min)	323 (330)	539 (549)	553 (673)
Pain (0-10)	5.3 (1.7)	6.6 (2.0)*	5.2 (1.8)

*p<0.05 compared with baseline. PA, Physical Activity. For (moderate) PA a higher score indicates an improvement. For pain, a lower score indicates an improvement.

Table 4: HOOS and KOOS scores (mean and SD)

	HOOS baseline	HOOS 6 weeks	HOOS 12 weeks	KOOS baseline	KOOS 6 weeks	KOOS 12 weeks
Pain (0-100)	54.2 (19.2)	55 (16.0)	59.3 (17.1)	45.6 (18.5)	47.8 (17.4)	49.1 (15.1)
Symptoms (0-100)	49.6 (16.5)	48.9 (13.7)	58.8 (16.2)	61 (16.8)	55.2* (16.0)	62.6 (14.9)
ADL (0-100)	53.2 (20.3)	49.2 (14.9)	54.9 (17.4)	46.8 (20.1)	46 (14.9)	47.5 (20.6)
Sport (0-100)	33.3 (23.4)	18.8* (18.0)	45.1 (33.9)	18.2 (16.1)	16.3 (18.6)	15 (19.1)
QOL (0-100)	37 (18.8)	38.5 (13.7)	41 (12.9)	27.9 (17.7)	32.9 (14.1)	34.1 (12.0)

$p<0.05$; HOOS/KOOS, The Hip/Knee Osteoarthritis Outcome Score; ADL, activities of daily life; QOL, Quality of life. For all outcomes a higher score indicates an improvement.

Feasibility and acceptability

The majority of participants (n=12, 60%) selected walking as the central activity. Other selected activities were floor exercises (n=3, 15%), cycling (n=1, 5%), domestic tasks (n=1, 5%), gardening (n=1, 5%), and rowing (n=1, 5%). A total of twenty participants commenced the intervention with the program introduction. Login-file analyses revealed that 100% (n=20) of the users completed the introduction module. Overall, 55% (n=11) of the participants completed at least 75% of the program (≥7 week assignments). 70% (n=14) achieved 60% program exposure and 30% (n=6) were exposed to at least 30% of the intervention. The exposure percentage declined over time. The most listed reasons for skipping a weekly PA were other commitments or of lack of time. Adverse events, such as extreme pain or injuries, were not reported during the program. The 16 interviews revealed that performing the activities in one's own time and at one's own pace was regarded as convenient. In general, participants perceived the website as an additional motivation to perform PA. However, the interviews also revealed an important usability issue. It became clear that patients were dissatisfied with the rigid character of Join2move. As one user commented "When I skipped my weekly PA exercise due to other commitments, I had no opportunity to repeat that exercise. That was frustrating". The results from the SUS among 15 participants revealed an average score of 73 points (SD 15) on a 100-point scale questionnaire. According to the study of Bangor et al. [40], this score can be considered "good". Only two patients disagreed with the statement "The website was easy to use" and nearly all patients disagreed with the statement "I think I would need technical support to be able to use the program".

Usability tests

Experts in heuristic evaluation rated the rigid character of the intervention as a disadvantage. This was in accordance with results from the interviews. Results of the Thinking Aloud test are given in Table 5. The majority of tasks were completed as expected. Of the 15 tasks presented, on average, 12 (80%) were completed successfully. However, several usability problems were identified. Respondents had difficulties in logging (task 4), completing the introduction module (task 5) and establishing their personal starting level

(task 14). On all occasions, navigation to Aim of the Program (task 10) was not executable due to an error in the system.

Table 5: Thinking Aloud test among 5 participants

Tasks		Average time (sec)	Task correct
1.	What is the moderator's telephone number?	15.60	100% (n=5)
2.	Register yourself for the program	308.40	100% (n=5)
3.	Search for information about healthy weight and osteoarthritis	68.60	80% (n=4)
4.	Login (with your username and password)	85.60	60% (n=3)
5.	Complete module 1 (introduction)	352.40	40% (n=2)
6.	Navigate to the webpage 'Symptoms'	48.20	60% (n=3)
7.	Navigate to the webpage 'My profile'	12.20	100% (n=5)
8.	Watch home exercise video No. 4	23.00	80% (n=4)
9.	Write something in your workbook	84.60	100% (n=5)
10.	Navigate to the webpage 'Programme Aim "	82.80	0% (n=0)
11.	Log out	2.00	100% (n=5)
12.	Log in, once again	59.40	100% (n=5)
13.	Fill in the evaluation form (performance and perceived pain)	62.00	100% (n=5)
14.	Check the starting point of your programme in minutes	73.80	60% (n=3)
15.	Check your most recent update in your workbook	16.20	100% (n=5)

Adjustments

Based on the results of the interviews and the heuristic evaluation, we changed the program's time contingent structure (i.e. fixed time periods) into a more flexible format. In the most recent version, options have been included which give users the choice of repeating modules and adapting the difficulty of the modules. The usability errors from the Thinking Aloud approach had more to do with the design of the website and the location of several buttons. These relatively minor problems were also addressed.

Discussion

Results from this study indicate that Join2move is a plausible, feasible and acceptable program for patients with knee and/or hip OA. Although effectiveness was not proved due to the lack of power, results do indicate that Join2move has the potential to increase PA levels in patients with knee and/or hip OA. Participants reported higher levels of PA, particularly (and as expected) involving moderate activities like walking and cycling (200 minutes). In line with other research [41], walking was by far the most frequently selected activity. Our positive results correspond with a comparable face-to-face intervention, showing a moderate PA increase of 170 minutes [25]. In the first three weeks, the increase was accompanied by more pain. Fortunately, after twelve weeks the pain scores declined towards baseline levels. Although the intervention focused on improving PA rather than on pain reduction, the increased pain was certainly a reason for concern. The precise cause of observed elevated pain scores is unclear. A possible explanation is the increased PA which may generate more muscle and joint pain. However, it is important to note that higher levels of pain are not associated with deterioration of OA [42,43].

Providing an intervention does not automatically mean that patients will use it, particularly when it is self-directed, with minimum personal contact. Since the success of web-based interventions requires active participation, nonusage attrition has been pointed out as a common concern in the field of web-based education. In line with other studies, [21,22,44], the number of users gradually decreased during the nine-week program. Overall, 55% (n=11) of the participants completed at least 75% of the program. This exposure percentage corresponds with the study of Steele et al. [33] and can be rated as reasonably high for web-based interventions without human interference. The delivery of personal information on a weekly basis is a possible explanation for this relatively low nonusage attrition. In this respect, it was not possible for users to run the entire program at one time. Although we did not examine the specific strategies of engagement, the authors assume that the week-by-week basis provided an incentive to return to the website.

With respect to usability, the involvement of end-users was extremely valuable for identifying usability issues and system flaws. Along the way, we incorporated greater flexibility into the program. The implemented changes resulted in a less rigid version with more options tailored to the performance of the individual user.

The findings from this study need to be interpreted in light of the study's limitations. The small sample size, single group design and lack of long-term assessments limit conclusions of causality, long-term effects and generalizability. Furthermore, the potential presence of the so-called Hawthorne effect may have contributed to an overestimation of PA scores. This implies that observed PA changes may be partly the result of study participation. Besides the Hawthorne effect, self-reported PA measures may also contribute to an over-estimation of PA levels in this study. This may be a consequence of recall error, perceived social desirability and other biases. To obtain the best results, a combination of validated questionnaires with objective measures would be preferable in future studies. Another limitation concerns outside-care patients who lack computer skills or internet access. These groups are mostly excluded from web-based interventions. Unfortunately, this disadvantage applies also to the Join2move intervention. Typically, these patients are disproportionately less educated and have a lower income. Particularly with regard to these under-served populations, GPs should refer sedentary OA patients more frequently to a physical therapist or other health care provider. Further, it will be important to translate Join2move for other self-help platforms, such as videos, brochures and self-help books. A final limitation is that we only performed one Thinking Aloud test to detect and resolve usability issues. Unfortunately, we did not retest the redesigned intervention. In order to optimize usability for the implementation phase, a repetition of this procedure is advised.

Conclusions

Strong evidence indicates that regular PA is important in the management of OA. To date, however, many patients with knee and/or hip OA remain

sedentary. Unfortunately, the vast majority of these patients do not receive any help in the promotion of PA. Low-cost, effective and accessible PA interventions are needed. Although our results are not conclusive, this study suggests that Join2move has the potential to contribute to meeting this need. The intervention is unique, since this is the first web-based PA intervention focusing on outside-care patients with OA. Moreover, while most web-based PA interventions have additional human contact, the Join2move intervention is fully computerized. Given the fully automatic character, the program has the potential to reach large populations while placing a minimal burden on our scarce health resources. This paper illustrates how involving end-users and experts can contribute successfully to the development of a web-based self-help intervention. The results suggest that the intervention is feasible and acceptable in promoting PA among patients with knee and/or hip OA. The intervention was easy to use and satisfaction with the program was high. This suggests that the intervention is acceptable for patients with knee and hip OA. Preliminary results from the pilot study revealed that PA scores increased, although differences were not statistically significant. A randomized controlled trial is needed to determine the effectiveness of the Join2move program.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DB was responsible for day to day management of the project, developed the web-based intervention, collected all data, analysed the data and wrote the paper. CV had the idea for the study and managed the project. JD and DdB contributed to the intellectual content of the manuscript. All authors read and approved the final document.

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Appendices

Appendix 1: Usability items used for the heuristic evaluation

Interaction

1) Are the links to websites consistent throughout the website?
2) Do buttons and links show that they have been clicked?
3) Does the 'back' button appear on the browser toolbar on every page?
4) Are error pages descriptive, and did they provide a solution to the user?
5) Does the system inform users what is going on through appropriate feedback within a reasonable time frame?
6) Does the system behave consistently?
7) Does the system eliminate error-prone conditions and present users with confirmation options before they commit to the action?

Information and architecture

8) Is the path for any given task a reasonable length (2–5 clicks)?

Visual design

9) Is the default font size 12-point or larger? If not, is there an obvious way on the page to increase the font size? If not, does changing the font size in the browser enlarge all of the text?
10) Are text and interaction elements a different colour from the background? Are clickable items highlighted differently from other non-clickable highlighted items?

Information design

11) Has the amount of text been minimized; is only necessary information presented?
12) Is the content written in the active voice, directed to "you"?
13) Does the site use words that most older adults know? Are instructions written in plain language?
14) Is a relevant help button provided? Does the system provide documentation about the website?

Persuasive principles

15) Can users relate to and feel familiar with the context, images and figures that appear in the program?
16) Does the system contain the knowledge to be learned?
17) Is the program easy to use and are the tasks easy to perform with a small number of steps and keystrokes?
18) Can users learn about how they solved the tasks on previous occasions when the system was used?
19) Are users aware that the moderator can observe and see the results?
20) Do users get rewards or praise when a task is performed correctly
21) Is the program perceived as helpful?
22) Does the program act as a coach?

4

Effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis: randomized controlled trial

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Abstract

Background Patients with knee and/or hip osteoarthritis (OA) are less physically active than the general population, while the benefits of physical activity (PA) have been well documented. Based on the behavioral graded activity treatment, we developed a Web-based intervention to improve PA levels in patients with knee and/or hip OA, entitled "Join2move". The Join2move intervention is a self-paced 9-week PA program in which the patient's favorite recreational activity is gradually increased in a time-contingent way.

Objective The aim of the study was to investigate whether a fully automated Web-based PA intervention in patients with knee and/or hip OA would result in improved levels of PA, physical function, and self-perceived effect compared with a waiting list control group.

Methods The study design was a two-armed randomized controlled trial which was not blinded. Volunteers were recruited via articles in newspapers and health-related websites. Eligibility criteria for participants were: (1) aged 50-75 years, (2) self-reported knee and/or hip OA, (3) self-reported inactivity (30 minutes of moderate PA, 5 times or less per week), (4) no face-to-face consultation with a health care provider other than general practitioners, for OA in the last 6 months, (5) ability to access the Internet weekly, and (6) no contra-indications to exercise without supervision. Baseline, 3-month, and 12-month follow-up data were collected through online questionnaires. Primary outcomes were PA, physical function, and self-perceived effect. In a subgroup of participants, PA was measured objectively using accelerometers. Secondary outcomes were pain, fatigue, anxiety, depression, symptoms, quality of life, self-efficacy, pain coping, and locus of control.

Results Of the 581 interested respondents, 199 eligible participants were randomly assigned to the intervention (n=100) or waiting list control group (n=99). Response rates of questionnaires were 84.4% (168/199) after 3 months and 75.4% (150/199) after 12 months. In this study, 94.0% (94/100)

of participants actually started the program, and 46.0% (46/100) reached the adherence threshold of 6 out of 9 modules completed. At 3 months, participants in the intervention group reported a significantly improved physical function status (difference=6.5 points, 95% CI 1.8-11.2) and a positive self-perceived effect (OR 10.7, 95% CI 4.3-26.4) compared with the control group. No effect was found for self-reported PA. After 12 months, the intervention group showed higher levels of subjective (difference=21.2 points, 95% CI 3.6-38.9) and objective PA (difference=24 minutes, 95% CI 0.5-46.8) compared with the control group. After 12 months, no effect was found for physical function (difference=5 points, 95% CI −1.0 to 11.0) and self-perceived effect (OR 1.2, 95% CI 0.6-2.4). For several secondary endpoints, the intervention group demonstrated improvements in favor of the intervention group.

Conclusions Join2move resulted in changes in the desired direction for several primary and secondary outcomes. Given the benefits and its self-help format, Join2move could be a component in the effort to enhance PA in sedentary patients with knee and/or hip OA.

Trial registration The Netherlands National Trial Register: NTR2483; http://www.trialregister.nl/trialreg/admin/rctview.asp?TC=2483 (Archived by WebCite at http://www.webcitation.org/67NqS6Beq).

Introduction

It has been recognized that regular physical activity (PA) positively impacts the severity and course of numerous chronic diseases [1,2]. Among patients with knee and/or hip osteoarthritis (OA), regular PA has proven to be beneficial in preserving physical function and reducing pain symptoms [3,4]. Improvement in physical function and reduction in pain are positively related to several psychological factors and thus may affect self-esteem, pain coping, and self-efficacy in patients with knee and/or hip OA [5,6]. However, due to pain and other symptoms, patients with OA are less physically active than the general population [7,8]. Therefore, PA as a non-pharmacological intervention has been advocated in the treatment of OA patients [9].

Since OA is mainly managed within primary care, general practitioners (GPs) are advised to stimulate patients to adopt and maintain higher levels of PA. In practice, however, a GP's ability to encourage physical exercise is limited by time constraints and lack of standard protocols [10-12]. At the same time, it is unlikely that patients with knee and/or hip OA receive help elsewhere, since patients are not referred to other health care professionals [13] and because people often view their peripheral joint pain as an inevitable part of aging [14]. Numerous patients lack knowledge and skills to modify their PA routines and have negative concerns (eg, fear of pain and catastrophizing thoughts) about the impact of PA on their joints [15,16].

In an attempt to promote a more physically active lifestyle among patients with knee and/or hip OA, effective PA interventions are needed. With the explosion of Internet accessibility, Web-based interventions seem to provide a novel medium to reach patients with knee and/or hip OA; 61% of Europeans and 79% of North Americans have Internet access [17]. In the Netherlands, 95% of adults (55-65 years) and 75% of older adults (65-75 years) have access to Internet in their home [18]. Web-based interventions are applications available through a website with the intent to enhance understanding of a health condition and to change health behavior. In particular, Web-based interventions with minimal human contact have the

potential of high reach, low costs, and are accessible anytime and anywhere [19]. Previous Web-based interventions for inactive populations and patients with a chronic disease (eg, diabetes, cardiovascular diseases, and chronic obstructive pulmonary disease) have produced inconclusive findings [20-22].

To date, there are no Web-based PA interventions for patients with knee and/or hip OA that we know of. Given the advantages of the Internet, we developed "Join2move". The Join2move program differs from existing Web-based programs since it focuses on knee and hip OA and strategies to enhance PA despite the presence of pain. The design is inspired by a previously developed exercise program known as the behavior graded activity (BGA) program [23]. The BGA treatment is an exercise regimen based on operant behavior principles that stimulate OA patients to gradually increase their daily life activities for fixed time periods. In accordance with the BGA treatment, Join2move intervention is a 9-week PA program in which the patient's favorite recreational activity is gradually increased in a time-contingent way. The intensity of the modules is predetermined by the participants themselves. To investigate the effectiveness of Join2move, we compared the Web-based intervention versus no intervention. This study aimed to answer the following research question: "What is the short (3 months) and long-term (12 months) effectiveness of the Join2move intervention in patients with knee and/or hip OA in PA, physical function, and self-perceived effect in comparison with a waiting list control group?"

Methods

Study design

This study was a two-armed, 12-month, randomized controlled trial (RCT) with continuous recruitment and data collection. Allocation ratio was 1:1 and enrollment started on January 3, 2011, and ended November 5, 2011. The trial is reported according to the CONSORT-EHEALTH checklist [24]. Ethics approval was obtained from the medical ethics committee of the VU University Medical Center, Amsterdam.

Participants

Patients with self-reported knee and/or hip OA were recruited through advertisements in Dutch newspapers and online on health-related websites. The advertisements briefly explained the purpose of the project and the beneficial health effects of PA. Interested individuals were referred to an open access study website and invited to complete an online eligibility questionnaire. Participants' email addresses were used to contact them for online follow-up questionnaires, and home addresses were used for sending an information letter, informed consent form, and accelerometer. The eligibility criteria for participants were: (1) aged 50-75 years, (2) self-reported OA in knee and/or hip, (3) self-reported inactivity (<30 minutes of moderate PA three or five times or less per week), (4) no face-to-face consultation for OA with a health care provider, other than GP, in the last 6 months, (5) ability to access the Internet weekly, and (6) no contra-indications to exercise without supervision. Self-reported OA was determined by asking participants if they had a painful knee or hip joint and if a doctor or other health care provider had ever told them this was a result of OA. Contra-indication was determined by the PA-readiness questionnaire (PARQ) [25]. The PARQ questionnaire is designed to identify persons for whom increased PA may be contra-indicated. If patients filled out "no" to all questions, it was considered safe for the patients to engage Join2move. If participants answered "yes" to any of the seven PARQ questions, they were advised to see their GP before participation. Written medical clearance from a GP was not required.

Procedure

Interested patients who met the inclusion criteria were sent an invitation letter with informed consent. Once informed consent was obtained, participants were invited to fill out an online baseline questionnaire. When baseline assessments were completed, participants were randomly assigned to the intervention (n=100) or control group (n=99). For concealment, a researcher (CV), not involved in data collection, distributed sequentially numbered opaque sealed envelopes with allocation details. Each sealed envelope was opened after the participant had given their written consent to participate in the study. After randomization, all participants were informed

through email of their group assignment. Participants in the intervention group received a username and password to log in. Due to the nature of the study (waiting list controlled), neither the study staff nor the participants were blinded to group allocation. To assess the effectiveness of the Join2move intervention, we conducted two post measurements at 3 months and 12 months. At these follow-up times, all participants received online questionnaires. In addition to the online questionnaires, a random subgroup from both groups (n=83) received and returned an accelerometer by post. The decision for sending accelerometers to a subgroup of participants was made based on time and cost savings. An email and telephone reminder was used when participants failed to complete their online questionnaire within 2 weeks. Apart from sending accelerometers and telephone reminders, the study used an automated design. There was no face-to-face contact with study subjects.

Development of the intervention

Over the course of 1 year, a team of experts from the Netherlands institute for health services research (NIVEL) developed the program. During the development phase, an iterative design methodology [26] was used to test, analyze, and refine the Join2move intervention. We conducted a focus group (n=5), in home observations (n=4), a pilot study (n=20), and interviews (n=16). Furthermore, two usability methods (heuristic evaluation and a thinking aloud approach) were applied to determine the usability of the Web-based program. End-users (ie, patients with knee and/or hip OA) were involved continuously throughout the development process. The final version was used for the RCT study. No content changes were made during the trial period. Further details about the development are described elsewhere [27]. Participants involved in the focus group, pilot, and usability studies did not participate in the RCT study.

The intervention

The Join2move intervention is based on a previously developed and evaluated BGA program for patients with knee and/or hip OA [23]. The BGA program incorporates a baseline test, goal setting, time-contingent PA objectives (ie, on fixed time points), and text messages to promote PA. An

essential component of the BGA program is the positive reinforcement of gradual PA, despite the presence of pain. The gradual increase in activities changes the perception that PA is related to pain and reinforces confidence to improve PA performance [28]. The Join2move intervention is a fully automated Web-based intervention that contains automatic functions (web-based text messaging and automatic emails) without human support. Screenshots illustrating different stages of the Join2move intervention are presented in Multimedia appendix 1. Participants are initially presented with a homepage (see Figure 1). The password-secured PA program is available 24/7 from the homepage and is provided without charge. In keeping with the BGA treatment, the Join2move intervention is a self-paced 9-week PA program in which a patient's favorite recreational activity is gradually increased in a time-contingent way. In the first week of the program, users select a central activity such as cycling, walking, or gardening; perform a 3-day self-test; and determine a short-term goal for the next 8 weeks. Based on test performances and a short-term goal, 8 tailored weekly modules are automatically generated. Every week, new modules are posted on the password-secured website. Modules remain on the website for 1 week. After 7 days, users are presented with an evaluation form about pain and performance. Pain is assessed with a 10-point Numerical Rating Scale (0 is no pain, 10 is worst possible pain). Performance was measured by three items, namely: (1)"I completed the module as instructed", (2) "I did more than the instructed module", or (3) "I did less than the instructed module" due to "(a) time constraints, (b) weather conditions, (c) pain in my knee and/or hip, and (d) other physical complaints". Subsequently, tailored to the answers from the evaluation form, automated text-based messages were generated. Furthermore, if users indicated that a module was missed due to time constraints or weather conditions, they had the option to repeat the current module or to continue with the next module. If users indicated that a module was missed due to pain in knee/ hip or other physical complaints, they had the ability to repeat the module (a maximum of three times), adapt the intensity of the module, or proceed with the next module. In addition to the weekly modules, information about OA, lifestyle, and videos are provided. Since personal messages are updated on a weekly basis, users are encouraged to log in once a week. Automatic emails are generated if

participants do not log on to the website for two weeks. At the end of the program, the website presents a motivational message to perform regular PA in the future.

Figure 1: Join2move homepage

Waiting List

In this study, we used a waiting list control group. The control group (as well as the intervention group) received a letter with information about the study, PA, and OA. During the follow-up period, participants from the control group had no contact with participants from the intervention group and no access to the Join2move intervention. After the follow-up period, patients in the waiting list group received access to the Join2move intervention.

Measures

Three online questionnaires (0, 3, and 12 months) were used for data collection and a subgroup of participants received an accelerometer to measure PA. Questionnaires were created by online survey experts from the NIVEL institute and tested among a pilot study of 20 participants prior to the

RCT study [27]. All participants received an email with a URL link to an online questionnaire. We offered no incentives to complete questionnaires.

Demographic and clinical outcomes

Gender, education (low: primary and lower vocational education; middle: secondary and middle vocational education; high: higher vocational and university education), body height (centimetres), age (years), body weight (kilograms), location of OA complaints (knee, hip, or both), duration of OA complaints (years and months), and presence of comorbid conditions were obtained. Body mass index (BMI) was calculated as the weight in kilograms, divided by the height in meters squared.

Program usage

Program usage was measured by the number of weekly modules completed. A module consisted of a text-based assignment and accompanying evaluation form, which was presented on the website for 7 consecutive days. Once a participant read the weekly assignments and filled out the evaluation form, the module was defined as completed and the user was automatically presented with a new module. In total, there were nine weekly modules that could have been opened by the participant. This was automatically registered. Adequate program use was defined if users completed at least 6 out of 9 modules. Intervention supplements (ie, videos and general information on the homepage) were not included in the adherence measure.

Primary outcome measures

Physical Activity

Self-reported PA was measured by the validated PA Scale for the Elderly (PASE) [29]. The PASE questionnaire is designed to assess PA patterns in older adults. The instrument consists of questions on household, leisure time, and work-related activities. The activities (assigned according to the level of intensity: light, moderate, and strenuous) are recorded as never, seldom (1-2 days/week), sometimes (3-4 days/week), or often (5-7 days/week). The amount of time spent in each activity is multiplied by its intensity. In addition to the PASE questionnaire, assessment of PA was supported

through ActiGraph GT3X tri-axial accelerometers [30]. A random subsample of participants from the intervention and control groups were invited to wear this accelerometer. In total, 83 accelerometers were distributed by post to 41 controls and 42 participants in the intervention group. Participants were instructed to wear the monitor on a belt around their waist for 5 consecutive days [31], except during sleeping, showering, or swimming. In addition, participants were requested to fill out a short activity diary. This diary contained questions about wearing time, unusual activities, and reasons for device removal. When accelerometers and diaries were returned by post, data were downloaded, processed, and subsequently analyzed. Participants with at least 10 hours of PA data for at least 4 valid days were included for further analysis. In order to determine the actual PA thresholds, the widely accepted thresholds by Freedson et al [32] were used: 0-99 counts for sedentary activities, 100-1951 for light PA, 1952-5724 moderate PA, 5725-9498 for vigorous PA, and 9499-max for very vigorous activities. The total time spent in light, moderate, and (very) vigorous PA was summed and subsequently divided by the number of days worn to compute the daily average time spent in total activity. For analysis, data were recorded at 1-minute intervals. Sequences of at least 60 minutes of zero counts were defined as non-wearing time. Although the accelerometer was tri-axial, only the vertical axis was used for analysis. This was decided since preprogrammed thresholds of the tri-axial model have yet to be determined [33].

Physical function

Physical function was determined by a subscale of the Knee OA Outcome Score (KOOS) [34,35] and the Hip Injury OA Outcome Score (HOOS) [36,37]. The KOOS and HOOS are self-administered questionnaires to assess patients' opinions about their knee and/or hip-related problems according to five indicators on a 5-point Likert scale: (1) pain, (2) symptoms, (3) physical function, (4) sport and recreation function, and (5) quality of life.

Self-perceived effect

At 3 months and 12 months, self-perceived effect was assessed by a single question that asked participants about the degree of change since their previous assessment. We used a 7-point Likert scale ranging from "much worse" to "much better", with "about the same" located in the middle. The outcomes of self-perceived effect were dichotomized into "improved" (much better, better, and slightly better) and "not improved" (about the same, slightly worse, worse, much worse).

Secondary outcomes

Pain and fatigue were assessed with a 10-point Numerical Rating Scale (0 is no pain/not tired and 10 is worst possible pain/very tired). OA-related symptoms, quality of life, and sport and recreation were measured with a subscale of the HOOS and KOOS. Anxiety and depression were evaluated by the 14-item Hospital Anxiety and Depression Scale (HADS) [38]. Self-efficacy for pain and other symptoms was evaluated by using the Arthritis Self-Efficacy Scale [39,40]. Active and passive pain coping were determined by the Pain Coping Inventory questionnaire [41]. Locus of control (people's belief that health is or is not determined by their behavior) was examined with the Multidimensional Health Locus of Control Scale [42].

Sample size

Sample size calculations were performed. Since no previous research has provided adequate statistical information on PA, power calculations were based on physical function and self-perceived effect. We needed 200 patients with knee and/or hip OA in total to detect a small to medium effect (0.2-0.5) in the outcome measure physical functioning and self-perceived effect (25% difference). Conventional levels of statistical power (0.8) and level of statistical significance (P=.05) were used.

Statistical analysis

Findings were analyzed using an intention-to-treat analysis. Complementary to the primary analysis, per-protocol analysis was employed using only adherent patients in the intervention group (at least 6 out of 9 modules completed) and the entire control group. A nonresponse analysis was carried

out in order to examine differences among participants who completed the questionnaires and participants who did not. Furthermore, we compared primary baseline variables between the response and the nonresponse group in order to investigate selective attrition. A Generalized Estimating Equations (GEE) approach controlling for baseline values, age, OA location, and gender was used to analyze effects of the intervention on primary and secondary outcomes. An independent correlation structure was used to account for the within-subject correlations. Also, *t* tests and chi-square tests were used to compare baseline characteristics in the intervention and control group to perform nonresponse analysis and to determine selective attrition. Between-group effect sizes (ES) were calculated according to Cohen's *d*. Traditionally, ES of ≥0.8 are interpreted as "large" effects, effect sizes of 0.5 as "moderate", and effect sizes of ≤0.2 as "small" effects [43]. The effect size for self-perceived effect was given by odds ratios (OR). Since GEE analyses are tolerant to data missing, no imputation techniques were used [44].

Results

Participant characteristics and study participation

Figure 2 depicts the flow of participants throughout the trial. In total, 581 persons were screened, 278 (47.8%, 278/581) were eligible, and 200 (71.9%, 200/581) consented to participate. Finally, a total of 99 participants were assigned to the control group, and 100 participants were allocated to the experimental group. With regard to the questionnaires, the overall response rate was 84.4% (168/199) after 3 months and 75.4% (150/199) after 12 months. With respect to the subgroup of participants who wore an accelerometer (n=83), the overall response rate was 72% (60/83) and 66% (55/83) after 12 months. Reasons for not participating in the follow-up surveys were health/medical issues (37%, 17/46), lack of motivation (15%, 7/46), personal/family reasons (13%, 6/46), other (13%, 6/46), and unknown reasons (22%, 10/46).

Figure 2: Flow of participants throughout the trial

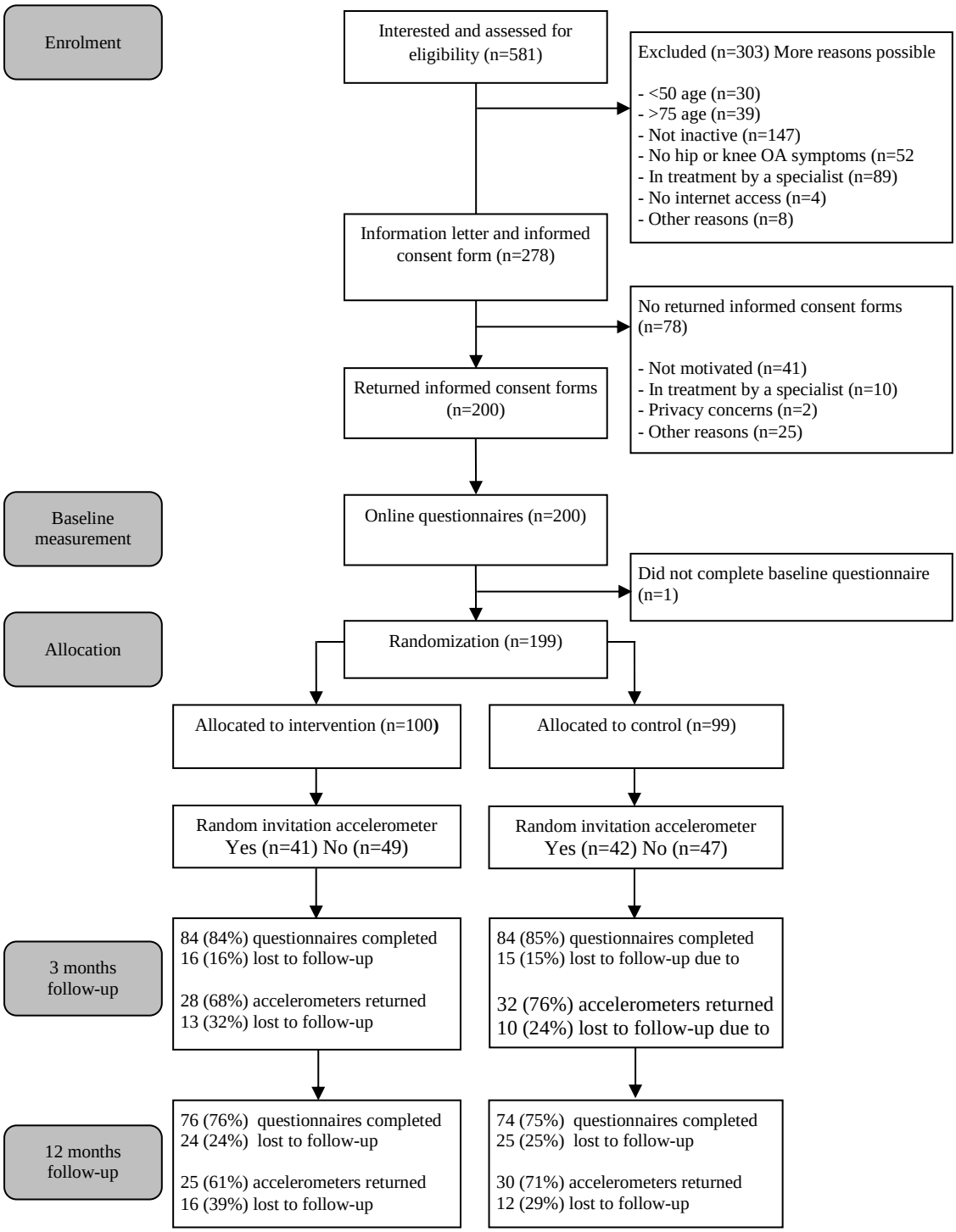
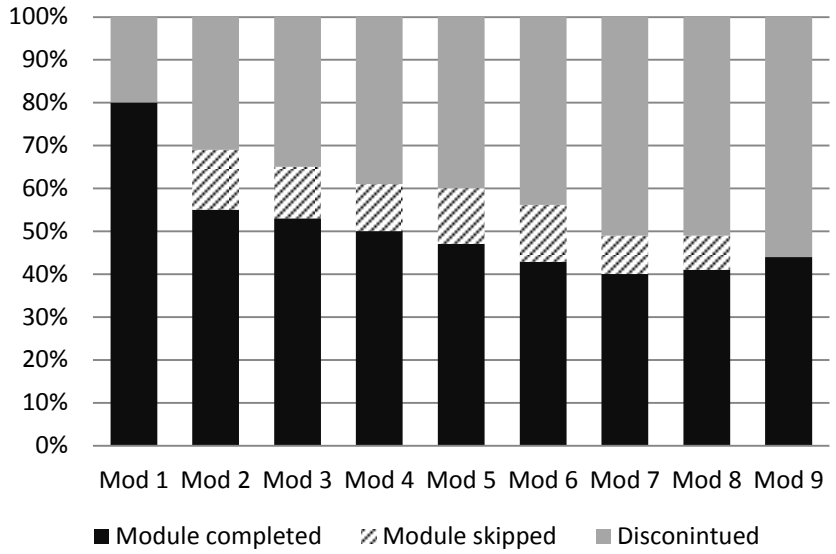


Table 1 presents participants' characteristics and primary outcome measures at baseline. Participants were predominantly female (64.8%, 129/199), had knee OA (63.8%, 127/199), and no comorbidity (62.8%, 125/199). Mean age was 62 years (SD 5.7) and mean BMI was 27.6 (SD 4.5). Of the participants, 45.7% (91/199) had a high level of education and 9.0% (18/199) had OA symptoms for less than 1 year. Demographic baseline values were not statistically different between the two groups. Those who did not complete follow-up questionnaires were more likely to have at least one comorbidity (*P*=.01) than those who did. With respect to other baseline characteristics, no differences were found (data not shown). The subgroup of participants (n=83) who wore an accelerometer did not differ from the other participants (n=116) on baseline characteristics (data not shown).

Table 1: Baseline demographic and clinical characteristics

Characteristic		Intervention, n=100	Control, n=99	*P* value
Gender, n (%)				
	Male	40 (40.0)	30 (30.3)	.15
	Female	60 (60.0)	69 (69.7)	
Age (years), mean (SD)		61 (5.9)	63 (5.4)	.05
BMI (kg/m^2), mean (SD)		27.6 (4.6)	27.5 (4.5)	.79
Location OA, n (%)				
	Knee	67 (67.0)	60 (60.6)	.37
	Hip	21 (21.0)	20 (20.2)	
	Both	12 (12.0)	19 (19.2)	
Duration of symptoms, n (%)				
	≤1 year	12 (12.0)	6 (6.1)	.33
	>1-3 years	28 (28.0)	27 (27.3)	
	>3-7 years	27 (27.0)	27 (27.3)	
	≥7 years	33 (33.0)	39 (39.4)	
Education				
	Low education	13 (13.0)	15 (15.2)	.36
	Middle education	36 (36.0)	43 (43.4)	
	High education	51 (51.0)	40 (40.4)	
Comorbidity, n (%)				
	None	65 (65.0)	60 (60.6)	.43
	One	19 (19.0)	16 (16.2)	
	Two or more	16 (16.0)	23 (23.2)	

Figure 3: Module completion rate



Primary outcome measures

Table 2 presents results of the primary outcome measures at 3 and 12 months. At 3 months, participants in the intervention group reported a significantly improved physical function status (P=.006, d=0.20) and a positive self-perceived effect (P<.001; OR 10.7, 95% CI 4.3-26.4). No effect was found for PA measured with the PASE questionnaire (P=.84, d=−0.01) and accelerometer (P=.83, d=0.02). After 12 months, the intervention group showed higher levels of subjective and objective PA (P=.02, d=0.18 and P=.045, d=0.19) compared with the control group. At 12 months, no effect was found for physical function (P=.10, d=0.17) and self-perceived effect (P=.50; OR 1.2, 95% CI 0.6-2.4). The accelerometer group (n=83) did not differ from the group who did not wear an accelerometer (n=118) with respect to short and long-term PASE scores (data not shown).

Table 2: Primary outcome measures: improvements and differences between groups[a]

Outcome measures	n	Intervention, mean (95% CI)	n	Control, mean (95% CI)	Difference, I-C[b] (95% CI)	ES	*P* value
Total PA, PASE (0-400)							
Baseline	100	163 (130-196)	97	160 (123-197)	—	—	—
3 months	85	162 (136-187)	79	163 (137-190)	−1.6 (−16.6 to 13.5)	−0.01	.84
12 months	74	174 (150-198)	71	153 (125-181)	21.2 (3.6-38.9)	0.18	.02
Total PA (accelerometer min/day)							
Baseline	39	369 (299-439)	40	395 (322-468)	—	—	—
3 months	27	361 (312-411)	30	358 (310-407)	3 (−26 to 32)	0.02	.83
12 months	24	361 (317-406)	28	338 (291-384)	24 (0.5-46.8)	0.19	.045
Physical functioning (0-100)							
Baseline	99	58.8 (51.5-66.0)	98	55.2 (47.9-62.5)	—	—	—
3 months	84	67.8 (59.2-76.4)	80	61.3 (52.7-69.9)	6.5 (1.8-11.2)	0.20	.006
12 months	75	67.9 (59.1-76.7)	72	62.9 (54.1-71.7)	5.0 (−1.0 to 11.0)	0.17	.1
Self-perceived effect (improved-not improved)							
3 months, n (%) improved	85	44 (44)	83	7 (7.1)	10.7[c] (4.3-26.4)	—	<.001
12 months, n (%) improved	76	34 (34)	74	27 (27.3)	1.2[c] (0.6-2.4)	—	.5

[a]For PA, physical functioning, and self-perceived effect, a higher score indicates an improvement. Results are based on GEE analyses and adjusted for corresponding baseline variables, age, OA location, and gender.
[b]I-C: difference between intervention and control group.
[c]odds ratio

Secondary outcome measures

Table 3 presents results of the secondary outcome measures at 3 months and 12 months. At 3 months, we observed statistically significant differences between the intervention and control group with respect to pain (P=.002; d=−0.2), tiredness (P=.04, d=−0.16), and improvements in self-efficacy for pain (P=.008, d=0.17) in favor of the intervention group. Other secondary endpoints were not significantly different between the two groups. At 12 months, subjects in the intervention group reported less tiredness (P=.008; d=−0.22), better passive pain coping scores (P=.008, d=−0.18), and reduced anxiety levels (P=.007; d=−0.21) compared to those in the control group. Other secondary outcomes were not significantly different between the conditions at 12 months.

Table 3. Secondary outcome measures: improvements and differences between groups[a]

Outcome measures	n	Intervention, mean (95% CI)	n	Control, mean (95% CI)	Difference, I-C[b] (95% CI)	ES	*P* value
Sedentary intensity (accelerometer min/day)							
Baseline	39	571 (498-645)	40	555 (479-630)	—	—	—
3 months	27	508 (454-563)	30	540 (477-603)	−32 (−67.7 to 3.7)	−0.20	.08
12 months	24	514 (448-580)	28	531 (467-595)	−17 (−54.7 to 20.7)	−0.10	.38
Pain (0-10)							
Baseline	100	5.4 (4.2-6.5)	98	4.9 (3.7-6.1)			
3 months	85	3.5 (2.5-4.6)	81	4.5 (3.4-5.7)	−1 (−1.6 to −0.38)	−0.20	.002
12 months	76	3.5 (2.4-4.5)	71	3.8 (2.7-4.9)	−0.36 (−1.1 to 0.38)	−0.07	.33
Tiredness (0-10)							
Baseline	100	5.6 (4.3-6.9)	99	5.5 (4.3-6.8)	—	—	—
3 months	85	3.2 (2-4.4)	81	4.1 (2.9-5.3)	−0.84 (−1.6 to -0.06)	−0.16	.04
12 months	76	3 (1.9-4.2)	71	4.1 (3-5.2)	−1.15 (−1.9 to −0.28)	−0.22	.008
Symptoms (0-100)							
Baseline	100	68.2 (60.2-76.2)	99	70.9 (62.7-79.2)	—	—	—
3 months	85	67.4 (59.1-75.8)	80	64.3 (55.3-73.2)	3.1 (−1.3 to 7.6)	0.08	.16
12 months	76	65.7 (57.4-74.0)	71	62.8 (53.4-72.1)	3 (−2.1 to 8.1)	0.08	.25
Quality of life (0-100)							
Baseline	100	38 (30.6-45.5)	98	40.9 (33.6-48.2)	—	—	—
3 months	85	49.4 (41.7-57.0)	80	47.3 (39.4-55.1)	2.1 (−1.7 to 5.9)	0.06	.28
12 months	75	48.7 (40.8-56.6)	71	47.5 (39.3-55.6)	1.2 (−4.4 to 6.8)	0.03	.68
Sport/recreation (0-100)							
Baseline	88	27.6 (14.7-40.4)	78	27.6 (13.4-41.9)	—	—	—
3 months	58	42.6 (29.6-55.6)	55	42.6 (29-56.2)	0 (−8.0 to 8.1)	0	1
12 months	53	42.4 (28.1-56.8)	47	39.6 (25.6-53.5)	2.9 (−6.3 to 12.1)	0.08	.54
Self-efficacy pain (1-5)							
Baseline	100	4.1 (3.6-4.6)	97	3.8 (3.6-4.2)	—	—	—
3 months	85	4 (3.6-4.4)	79	3.7 (3.3-4.1)	0.31 (0.1-0.5)	0.17	.008
12 months	75	4 (3.6-4.4)	72	3.9 (3.5-4.3)	0.12 (−01 to 0.4)	0.06	.35
Self-efficacy other symptoms (1-5)							
Baseline	100	3.6 (3.1-4.1)	96	3.8 (3.4-4.3)	—	—	—
3 months	85	4 (3.7-4.4)	79	3.8 (3.7-4.4)	0.21 (0-0.4)	0.12	.07
12 months	75	4.1 (3.7-4.4)	72	3.8 (3.5-4.2)	0.23 (0-0.5)	0.20	.05
Active pain coping (0-4)							
Baseline	100	2.2 (2.0-2.4)	96	2.2 (2-2.4)	—	—	—
3 months	83	2 (1.9-2.2)	77	2 (1.8-2.2)	−0.02 (−0.1 to 0.1)	−0.02	.81
12 months	73	2 (1.8-2.2)	70	2 (1.8-2.2)	0 (−0.1 to 0.1)	0	.98
Passive pain coping (0-4)							
Baseline	100	1.8 (1.7-2.0)	96	1.8 (1.6-1.9)	—	—	—
3 months	83	1.7 (1.6-1.8)	77	1.7 (1.6-1.9)	−0.04 (−0.1 to 0.04)	0	.29
12 months	73	1.7 (1.5-1.8)	70	1.8 (1.7-1.9)	−0.12 (−0.2 to –0.03)	−0.18	.008
Internal locus of control (6-36)							
Baseline	100	27.1 (25.1-29.2)	96	27.5 (25.2-29.8)	—	—	—
3 months	84	23.9 (21.9-25.8)	79	23.4 (21.3-25.6)	0.45 (−0.6 to 1.5)	0.06	.41
12 months	74	23.6 (21.7-25.6)	70	24 (21.7-26.2)	−0.3 (−1.5 to 0.9)	−0.05	.61
Powerful others locus of control (6-36)							
Baseline	99	17.4 (14.8-20.0)	96	18.8 (15.8-21.8)	—	—	—
3 months	83	16.5 (15.0-18.0)	79	16.1 (14.3-18.0)	0.37 (−0.8 to 1.5)	0.05	.53
12 months	73	15.2 (13.6-6.9)	70	16 (14.1-17.9)	−0.74 (−2.0 to 0.6)	−0.1	.26
Anxiety (0-21)							
Baseline	100	4 (2.5-5.6)	97	4.2 (2.6-5.9)	—	—	—
3 months	85	3.5 (2.5-4.5)	79	4.2 (3.1-5.2)	−0.64 (−1.3 to 0)	−0.15	.05
12 months	75	3.1 (2.0-4.3)	72	4.1 (2.9-5.2)	−0.9 (−1.6 to −0.2)	−0.21	.007
Depression (0-21)							
Baseline	100	4 (2.5-5.6)	96	4.2 (2.6-5.9)	—	—	—
3 months	85	2.6 (1.5-3.7)	78	3.2 (2.1-4.3)	−0.61 (−1.3 to 0.1)	−0.12	.09
12 months	75	2.4 (1.3-3.6)	72	3 (1.9-4.2)	−0.6 (−1.3 to 0.1)	−0.12	.09

[a]For symptoms, quality of life, sport and recreation, self-efficacy, active pain coping, and locus of control, a higher score indicates an improvement. For sedentary behavior, tiredness, pain, passive pain coping, anxiety and depression a lower score indicates an improvement. Results are based on GEE analyses and adjusted for corresponding baseline variables, age, OA location, and gender.
[b]I-C: difference between intervention and control group.

Per-protocol analyses

The per-protocol analysis - a comparison of the adherent patients in the intervention group (ie, participants who completed 6 out of 9 week modules) and the entire control group - yielded positive self-perceived effects in favor of the intervention group (data not presented). Higher levels of participation had no influence on other primary and secondary outcomes (data not presented).

Discussion

To date, unfortunately, a vast majority of patients with knee and/or hip OA remain sedentary and receive no help in the promotion of PA. Since a physically active lifestyle has been positively associated with physical function and pain [45], effective and accessible PA programs are needed. Findings from other Web-based PA interventions have been mixed [22,46,47]. With respect to the PASE questionnaire, this randomized controlled trial demonstrated that the Join2move intervention has the potential to improve PA behavior. Effect sizes for PA ranged between 0-0.19 and are congruent with findings from a meta-analysis that found an overall mean effect of 0.14 [22]. At 3 months and 12 months, PA scores in the intervention group increased with 1% (1 point) and 6% (11 points) compared to baseline. Objectively obtained PA yielded different patterns. The intervention group remained stable while the control group reported a PA reduction of 37 minutes after 3 months and 57 minutes after 1 year. A possible explanation, also highlighted in other studies [48,49] is that self-reports tend to overestimate follow-up PA levels when compared to objective monitoring by accelerometry. At the same time, accelerometer measurements are unable to register water activities such as swimming. Since swimming is a popular recreational activity for older adults in the Netherlands, underestimation of objective PA may have occurred.

Besides PA, we also found significant short-term improvements in the primary outcomes physical function and self-perceived effect. Over the long term, however, we found no significant effects for physical function and

self-perceived effect. At 3 months and 12 months, physical function in the intervention group improved 15% (9 points) compared to baseline. According to a study by Roos et al [34], these values achieved the threshold of clinically meaningful improvement. Apart from the observed improvements in the primary outcome measures, we found beneficial effects for other physical (pain and fatigue) and psychological factors (self-efficacy, pain coping, and anxiety) in favor of the intervention group.

Since long-term follow-up studies demonstrated that effects of (Web-based) interventions are not sustained in the long term [21,22,50], we expected short-term rather than long-term PA effects. Surprisingly, we found only long-term effects in total PA. These results were confirmed by both self-reported and accelerometer data. Absence of short-term effects can be partly explained by improved self-reported PA outcomes in the control group. The potential presence of the so-called Hawthorne effect may have contributed to an overestimation of PA scores in the control group. Selective dropout, which may have enhanced the effects in the control group, was not found. A definitive explanation for the nonsignificant short-term differences remains unclear.

Several factors may have contributed to the success of the Join2move intervention. First, the program is the first Web-based PA intervention that focuses specifically on knee and hip OA. The intervention addresses how to perform PA despite the presence of pain. The gradual increase of activities changes the perception that physical movement is related to pain and reinforces confidence to improve PA performance [28]. This may have led to positive psychological and health outcomes. Second, the Join2move intervention seeks to align with the day-to-day activities of people. Users perform common activities (eg, walking, cycling) that are easy to integrate in their daily routine. Third, over the course of 1 year, we systematically developed and evaluated the Join2move intervention. End-users considered the intervention as user-friendly and helpful [27], which is a prerequisite for effective Web-based interventions.

Nonusage attrition has been acknowledged as a common concern in the field of Web-based education [51]. In particular, interventions, such as Join2move, that use automatic functions with minimal human involvement suffer from substantial rates of nonusage. In this study, 94.0% of the participants actually started the program, 46.0% reached the adherence threshold of 6 out of 9 modules, and 19.0% finished all 9 weekly modules. When considered in light of other studies, these adherence rates can be interpreted as reasonable. Previous studies by Wanner et al [52] and Connon et al [53] showed that respectively 47% and 25% of the intervention subjects never logged in to their Web-based program. Similarly, in a Web-based intervention by Hansen and colleagues [54], only 7% of the participants used the program more than once. A possible explanation for the relatively high adherence rates could be that our program incorporated automatic email reminders and website refreshments. We believe, like others [55-58], that more advanced feedback systems and regular reminders will lead to even better rates of adherence. Therefore, future research should concentrate on which strategies can improve website usage. A second factor, which may have influenced our usage rates, is the recruitment strategy used in this study. Participants were self-selected volunteers who responded to advertisements. Since self-selected participants tend to be highly educated, healthy, and already motivated to change their PA behavior, it is presumed that they have better usage rates compared to those who do not elect to participate. For example, Hansen et al [54] attributed their poor usage rates to the non-self-selected sample. This suggests that Web-based interventions, especially those without supervision, could be most suitable for those who are already willing to change their PA levels. Details about the usage and nonusage of the Join2move are described in another publication [59].

With respect to dropout attrition, 9% (4/46) adherent and 48% (26/54) nonadherent subjects did not return at least one of the follow-up surveys. This is in line with the study by Eysenbach [51], indicating that dropout and nonusage attrition are linked to each other. Since dropout rates and demographics of dropouts were similar between conditions, it is not expected that this influenced the results of the study.

As there is no cure for OA, self-management is considered a key element in the nonpharmacological treatment of knee and/or hip OA [60,61]. Self-management aims to motivate OA patients to undertake changes necessary to improve physical and psychological well-being. Although the importance is generally acknowledged, provision of self-management is underutilized. Given the clinically relevant benefits and the self-help format, Join2move could be a key component in the effort to enhance self-management in sedentary patients with knee and/or hip OA. Considering the unique potential to reach large populations through Join2move, even the small effects observed in this study could have clinical public health consequences [19]. Besides the focus on outside-care populations, patients in a care setting may also benefit from Join2move. Therefore, future work should integrate and investigate Join2move in a health care environment.

Strengths and limitations

First, the most important strengths are the design (ie, RCT) and the long-term character of the study. Second, we used both objective and subjective measures to assess PA. This study also has certain limitations that are important to acknowledge. First, participants were included on the basis of self-reported OA. Unfortunately, due to practical constraints, diagnosis was not confirmed through clinical tests or x-ray reports. In a previous pilot study [27], we verified self-reported OA through clinical tests. According to the American College of Rheumatology criteria [62,63], 80% had clinical knee or hip OA and 20% of the participants had no OA. These rates are in line with another validation study [64], reporting over 80% agreement between self-reported and clinically confirmed diagnoses. Although these rates are acceptable, it is presumed that we included false positive OA patients in our trial. Second, results could be biased by dropout of participants (15.6%, 31/199 at 3 months and 24.6%, 49/199 at 12 months). However, the nonresponse analysis showed similar baseline characteristics for responders, and nonresponders and dropouts were equally distributed between the intervention group and the control group. Third, with respect to the outcome variable PA, the study involved two different measures (questionnaires and

accelerometers) on two occasions (3 months and 12 months). We acknowledge that this may have increased the possibility of Type I errors. Fourth, the representativeness was limited by the self-selected sample used in this study. Responders were predominantly healthy and highly educated patients. This widely recognized phenomenon is called "The inverse information law" [65]; Web-based interventions fail to reach those for whom PA behavior changes are most necessary [21,22,66-69]. In order to eliminate this issue, future studies should focus on how these specific groups could be involved in the field of Web-based education.

Conclusions

Health care providers, such as GPs and physical therapists, may play a pivotal role in the referral of patients to Web-based interventions. Furthermore, it will be important to translate Web-based interventions, such as Join2move, to other self-help formats (eg, videos, brochures, and self-help books).

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Appendices

Appendix 1: Screenshots of the Join2move intervention


Artrose in Beweging.nl
Persoonlijk beweegprogramma
nivel
Aangemeld als Alberdina Ruiter
Mijn Profiel
Uitloggen
Mijn beweegprogramma
Thuisoefeningen
Leven met artrose
Over artrose
Contact
Werkboek
Introductie
1. Gezondheidsvragen
2. Centrale activiteit
3. Basismeting
4. Korte- en lange termijndoel
5. Bewegen met pijn
6. Beweegovereenkomst
Bepalen van huidig niveau
Uw niveau van de activiteit fietsen wordt bepaald aan de hand van een driedaagse meting. Op drie verschillende dagen voert u de activiteit fietsen uit zoals u dat nu gewend bent. Hierna noteert u het aantal minuten en de pijn die u voelde tijdens de activiteit. Deze gegevens kunt u op een willekeurig moment invullen in de onderstaande tabel. Probeer de meting binnen één week af te ronden. U kunt zich nu afmelden en op een willekeurig tijdstip terugkeren.
Let op! In het verleden is gebleken dat deelnemers snel geneigd zijn zichzelf te overschatten. Vult u de gegevens zo realistisch mogelijk in.
Dag Datum
Aantal minuten
Pijn tijdens activiteit: van 0-10 (0= geen pijn, 10= ondraaglijke pijn)
1 02-01-2014 35 min. 6
2 03-01-2014 50 min. 5
3 05-01-2014 45 min. 0 1 2 3 4 5 6 7 8 9 10
Opslaan


Artrose in Beweging.nl
Persoonlijk beweegprogramma
nivel
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Mijn Profiel
Uitloggen
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5. Bewegen met pijn
6. Beweegovereenkomst
Beweegovereenkomst
Wij hebben uw doel in een beweegovereenkomst gezet. Uw doel voor dit programma is als volgt geformuleerd:
"Over acht weken wil ik 85 minuten kunnen besteden aan fietsen"
Om dit doel te bereiken krijgt u wekelijks een activiteitenopdracht. Tijdens deze opdrachten wordt uw niveau van de activiteit fietsen stapsgewijs opgebouwd.
Verder willen wij het volgende met u afspreken:
U bent op de hoogte van uw persoonlijke korte termijn doel zoals hierboven is geformuleerd.
Als u meer gaat bewegen kunt u meer pijn krijgen in spieren en gewrichten. Dit zijn gezonde reacties van het lichaam. Deze pijn is vervelend, maar niet gevaarlijk.
U houdt zich, ondanks de pijn, aan de opdracht.
Ik ga akkoord met bovenstaande beweegovereenkomst.
Opslaan


Artrose in Beweging.nl
Persoonlijk beweegprogramma
nivel
Aangemeld als Alberdina Ruiter
Mijn Profiel
Uitloggen
Mijn beweegprogramma
Thuisoefeningen
Leven met artrose
Over artrose
Contact
Werkboek
Opdracht 1
Opdracht 2
Opdracht 3
Opdracht 4
Opdracht 5
Opdracht 6
Opdracht 7
Opdracht 8
Einde
Evaluatie van opdracht 1
Voordat u start met de volgende opdracht vragen wij u de vorige opdracht te evalueren. Uw opdracht afgelopen week was "Doe op drie verschillende dagen een kleine fietstocht van ongeveer 30 minuten"
Kunt u aangeven in hoeverre u deze opdracht heeft uitgevoerd?
Ik heb precies gedaan wat in deze opdracht staat aangegeven.
Ik heb minder gedaan dan deze opdracht.
Ik heb meer gedaan dan deze opdracht.
Vrije tekst (optioneel): Hoe is het gegaan met uw eerste opdracht?
Pijn
Hoeveel pijn heeft u gemiddeld ervaren tijdens opdracht 1?
(0= geen pijn, 10= ondraaglijke pijn)
0 1 2 3 4 5 6 7 8 9 10
Opslaan
Opbouw van uw programma
43 min.
85 min.
Begin niveau
Opbouw van uw programma - 8 opdrachten
Eind doel

5

Adherence to a web-based physical activity intervention for patients with knee and/or hip osteoarthritis: a mixed method study

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Abstract

Background Web-based interventions show promise in promoting a healthy lifestyle, but their effectiveness is hampered by high rates of nonusage. Predictors and reasons for (non)usage are not well known. Identifying which factors are related to usage contributes to the recognition of subgroups who benefit most from Web-based interventions and to the development of new strategies to increase usage.

Objective The aim of this mixed methods study was to explore patient, intervention, and study characteristics that facilitate or impede usage of a Web-based physical activity intervention for patients with knee and/or hip osteoarthritis.

Methods This study is part of a randomized controlled trial that investigated the effects of Web-based physical activity intervention. A total of 199 participants between 50-75 years of age with knee and/or hip osteoarthritis were randomly assigned to a Web-based intervention (n=100) or a waiting list (n=99). This mixed methods study used only data from the individuals allocated to the intervention group. Patients were defined as users if they completed at least 6 out of 9 modules. Logistic regression analyses with a stepwise backward selection procedure were executed to build a multivariate prediction usage model. For the qualitative part, semistructured interviews were conducted. Both inductive and deductive analyses were used to identify patterns in reported reasons for nonusage.

Results Of the 100 participants who received a password and username, 46 completed 6 modules or more. Multivariate regression analyses revealed that higher age (OR 0.94, P=.08) and the presence of a comorbidity (OR 0.33, P=.02) predicted nonusage. The sensitivity analysis indicated that the model was robust to changes in the usage parameter. Results from the interviews showed that a lack of personal guidance, insufficient motivation, presence of physical problems, and low mood were reasons for nonusage. In addition, the absence of human involvement was viewed as a disadvantage and it negatively impacted program usage. Factors that influenced usage positively

were trust in the program, its reliability, functionality of the intervention, social support from family or friends, and commitment to the research team.

Conclusions In this mixed methods study, we found patient, intervention, and study factors that were important in the usage and nonusage of a Web-based PA intervention for patients with knee and/or hip osteoarthritis. Although the self-guided components offer several advantages, particularly in relation to costs, reach, and access, we found that older patients and participants with a comorbid condition need a more personal approach. For these groups the integration of Web-based interventions in a health care environment seems to be promising.

Trial registration The Netherlands National Trial Register (NTR): NTR2483; http://www.trialregister.nl/trialreg/admin/rctview.asp?TC=2483 (Archived by Webcite at http://www.webcitation.org/67NqS6Beq).

Introduction

Osteoarthritis (OA) in the knee or hip is a prevalent musculoskeletal disorder characterized by joint pain, joint stiffness, and functional disability [1]. Regular physical activity (PA) has been recognized as an effective lifestyle strategy in the non-pharmacological management of knee and hip OA [2,3]. Despite recommendations, people with knee or hip OA are less physically active than the general population [4,5].

In an attempt to enhance a physically active lifestyle in patients with knee and/or hip OA, we developed a Web-based PA intervention. The intervention, entitled Join2move, is a self-paced 9-week PA program in which the patient's favorite recreational activity is gradually increased during fixed time periods. In a recent randomized controlled trial (RCT) among 199 participants with knee and/or hip OA [6], Join2move was demonstrated to be effective compared to a waiting list control group. Besides enhanced levels of PA, this study showed significant improvements in physical functioning, self-efficacy, pain levels, tiredness, and anxiety in the intervention group.

Unfortunately, substantial rates of nonusage were observed. A considerable proportion of potential users was never exposed to important program content. This is consistent with other studies [7-16]. For example, two studies [15,16] testing a Web-based PA intervention reported that 60% of their diabetes patients accessed the website once a week. The issue of nonusage is described in Eysenbach's Law of Attrition [17]. According to Eysenbach, characteristics related to the participant, intervention, and study may play a pivotal role in the adoption or rejection of Web-based interventions. Studies have demonstrated that older age groups [10,18-22], people with a healthy lifestyle [10,20], those with social ties [23], higher educated patients [22], and women [22,24] are more likely to adhere to Web-based interventions. In addition to user characteristics, the characteristics of the intervention itself can also influence usage. For instance, self-guided interventions with minimal human "push factors" (eg, online counseling or emails) show higher rates of nonusage than programs with substantial human

involvement [17,25,26]. Other intervention characteristics that predict usage are program duration and complexity. Generally, shorter, more concise interventions achieve better usage rates compared with more extensive interventions [27]. Moreover, it is known that study-related factors (eg, attention, commitment, and a belief in the importance of research), especially in RCTs [26], are positively related to usage [18,28].

Although considerable research has been devoted to quantitative predictors of nonusage, little qualitative research has been conducted on the underlying reasons for nonusage. Therefore, we conducted a mixed methods study to gain a deeper understanding of actual usage patterns, possible attrition predictors, and reasons for (non)usage. This is a necessary step toward enhancing program usage and may help us to make the Join2move intervention even more effective.

In this study, we utilized a mixed methods design employing both quantitative and qualitative (interviews) methods. By integrating the quantitative and qualitative results, we aimed to identify patient-, intervention-, and study-related characteristics that may facilitate or impede the usage of Web-based intervention for patients with knee and/or hip OA. Since this study was explorative by nature, no a priori hypotheses were formulated.

Methods

Study design and participants

Data from this study were retrieved from a randomized controlled trial that aimed at evaluating the effectiveness of the Join2move intervention for patients with hip and/or knee OA [6]. In brief, the design of the study was a randomized, nonblinded, controlled, two-arm trial. Ethical approval was obtained from the medical ethics committee of the VU University Medical Center Amsterdam. Enrollment started on January 3, 2011 and ended on November 5, 2011. Sedentary volunteers with knee and/or hip OA were recruited via articles in newspapers and health-related websites. The

eligibility criteria for participants were (1) aged 50-75, (2) self-reported OA in knee and/or hip, (3) self-reported inactivity (<30 minutes of moderate PA less than 5 days in a week), (4) no face-to-face consults for OA with a health care provider, other than general practitioner, in the last 6 months, (5) ability to access the Internet weekly, and (6) no contra-indications to exercise without supervision. In total, 199 eligible participants were randomly assigned either to the intervention (n=100) or waiting list control group (n=99). Baseline, 3-month, and 12-month follow-up data were collected via online questionnaires. Primary outcomes were PA, physical functioning, and self-perceived effect. Self-perceived effect was assessed by asking participants about the degree of change since their previous assessment (much worse to much better). Both short-term and long-term results revealed positive effects of Join2move with respect to PA, physical functioning, self-perceived effect, and several other secondary outcomes [6].

Intervention

Over the course of 1 year, experts from the Netherlands Institute for Health Services Research developed the Join2move intervention. The Join2move intervention is based on a previously developed and evaluated behavioral graded activity (BGA) program for patients with knee and/or hip OA [29]. Details of the Join2move intervention and the development process are described in another publication [30]. In brief, the Join2move intervention is a fully automated Web-based intervention that contains automatic functions (automatic messages on the website and automatic emails) without human support. Participants are presented with a homepage (see Figure 1). Join2move is a self-paced 9-week PA program in which the patient's favorite recreational activity is gradually increased in a time-contingent manner (ie, on fixed time points). In the first week, users select a central activity such as cycling or walking and perform a 3-day self-test. Based on the performance from the self-test, a range of goals is automatically generated and presented on the website. In this way, achievable goals are set. Users have the option to choose one of the proposed short-term goals between a lower and upper limit. Depending on the selected goal, 8 tailored modules are generated and presented weekly on the website. Modules remain on the website for 1 week. After 7 days, users are presented with an

evaluation form about pain and performance. Pain is assessed on a 10-point Numerical Rating Scale (0 is no pain, 10 is worst possible pain). Performance is measured by three items: (1) "I completed the module as instructed", (2) "I did more than the instructed module", and (3) "I did less than the instructed module" (due to time constraints, weather conditions, pain in my knee and/or hip, or other physical complaints). Subsequently, tailored to the answers from the evaluation form, automated text-based messages are generated. If users indicated that a module was missed due to time constraints or weather conditions, they had the option to repeat the current module or to continue with the next module. When users indicated that a module was missed due to pain in knee and hip or other physical complaints, they had the option to repeat the module (a maximum of three times), adapt the intensity of the module, or proceed to the next module. Since personal messages are updated on a weekly basis, users are encouraged to log in once a week. Automated emails are generated if participants do not log on the website for 2 weeks. At the end of the program, the website presents a motivational message to perform regular PA in the future. In total, the program lasted 9 weeks.

Figure 1: Homepage Join2move

Data collection and outcomes of the quantitative study

Program usage (ie, the number of completed program modules) was monitored throughout the intervention period. A module consisted of a text-based assignment plus accompanying evaluation form, which was presented on the website for 7 consecutive days. Once a participant had filled out the evaluation form 7 days after receiving the weekly assignment, the module was defined as completed and the user was automatically presented with a new weekly assignment. If a scheduled weekly module was missed, participants had the option to repeat the module, adapt the difficulty, or continue with the next module. In total, 9 weekly modules were available to the participant. This was automatically registered. After some consideration, the research team had decided that completion of at least 6 modules was required to improve PA and other primary effects. Patients were defined as users if they completed at least 6 out of 9 modules. Participants who did not reach this threshold were defined as nonusers. Predictors of usage were collected through online baseline questionnaires and can be categorized as demographic, clinical, or psychological predictors. The potential predictors were not selected on theoretical grounds.

Demographic predictors

Demographic predictors were gender, education (low: primary and lower vocational education; middle: secondary and middle vocational education; high: higher vocational and university education), and age (years) as demographic predictors.

Clinical predictors

Clinical predictors in this study were location of OA (knee, hip or both), duration of OA complaints (years), and body mass index (BMI) (weight in kilograms divided by height in meters squared). Pain and fatigue were assessed on a 10-point Numerical Rating Scale (0 is no pain/not tired, 10 is worst possible pain/extremely tired). Self-reported PA was measured by the validated PA Scale for the Elderly (PASE) [31]. The PASE questionnaire is designed to assess PA patterns in older adults. The instrument consists of questions on household, leisure time, and work-related activities. Performance of the activities (assigned according to the level of intensity:

light, moderate, and strenuous) is recorded as never, seldom (1-2 days/week), sometimes (3-4 days/week), or often (5-7 days/week). The amount of time spent in each activity is multiplied by its intensity. Physical functioning was determined by a subscale of the Knee OA Outcome Score (KOOS) [32,33] and the Hip Injury OA Outcome Score (HOOS) [34,35]. The KOOS and HOOS are self-administered questionnaires designed to assess patients' opinions about their knee- and/or hip-related problems. The questionnaires assess 5 indicators on a 5-point Likert scale: pain, symptoms, physical functioning, sport/recreation functioning, and quality of life. The presence of self-reported comorbidity was obtained through a specific list of comorbid diseases. The list described the most prevalent chronic diseases and disorders in The Netherlands [36].

Psychological predictors

Anxiety and depression were evaluated by a 14-item Hospital Anxiety and Depression scale [37]. Seven items on this questionnaire are related to anxiety and seven are related to depression. A lower score represents less anxiety and depression. Self-efficacy was evaluated by the Arthritis Self-Efficacy Scale for pain and other symptoms [38,39]. We used the subscales self-efficacy for pain and self-efficacy for other symptoms (eg, fatigue, depression). The score ranges from 1-10, where a higher score indicates greater self-efficacy.

Active and passive pain coping were determined by the Pain Coping Inventory questionnaire [40]. This 33-item questionnaire determines active and passive pain-coping strategies. A higher score on the active pain-coping subscale indicate a more adequate pain coping, and a higher score on the passive pain-coping subscale indicates inadequate pain coping. Locus of control, the extent to which one believes that one's health is determined by one's behavior, was examined with the Multidimensional Health Locus of Control Scale (MHLC) [41]. We used two subscales of the MHLC: (1) belief of control by powerful others (6 items) and (2) internal locus of control (6 items). For each subscale, a higher score indicates a greater level of belief in a particular subscale.

Data collection and outcomes of the qualitative study

One year after being assigned to the program, a subgroup of participants from the intervention group was interviewed. All participants from the intervention group (n=100) were categorized into two groups: (1) users and (2) nonusers. Since the nonuser group showed considerable divergence in extent of program use (0 to 5 modules), we decided to invite more nonusers than users for our interview sample. This was executed by a stratified purposive sampling procedure [42]. After the stratified sampling, participants were contacted by phone, invited to participate, and scheduled for a face-to-face interview until the sampling goal was reached. The goal was to conduct 15 interviews (10 users and 5 nonusers). To reach this sampling goal, 24 participants were invited; 15 agreed to be interviewed and 9 decided not to participate due to a lack of interest. All participants who declined to be interviewed were nonusers. Semi structured interviews were conducted by the same interviewer (MB) in the respondents' homes and lasted approximately 60 minutes. Interviews were digitally audio recorded with the participants' permission. The interviews were transcribed by means of the program Express Scribe [43]. During the interview process, we used an open-question guide (see Multimedia Appendix 1). This interview guide contained three topics: (1) patient characteristics, (2) intervention characteristics, and (3) study characteristics. The intervention characteristics contained three of the five themes described by Eysenbach's law of attrition [17]: (1) Relative advantage, the degree to which the innovation is perceived to be superior to the ideas that it replaces [44], (2) Complexity, the degree to which an innovation is perceived as relatively difficult to understand and use [44], and (3) Compatibility, the degree to which an innovation is perceived as being consistent with the values, experiences, and needs of potential adopters [44].

Analyses

Quantitative analyses

Descriptive analyses were performed to describe participant characteristics and program usage. Logistic regression analysis with a stepwise backward selection procedure was used to build the most parsimonious prediction

model. Program use (user/nonuser) was employed as a dichotomous dependent variable. Demographic, clinical, and psychological variables were the independent variables. Statistical analyses were conducted in two phases. First, potential predictors of interest were screened by univariate logistic regressions. Second, variables that achieved P<.20 were included in a multivariate stepwise regression analysis. Variables with the highest P value were removed one by one, until all remaining variables were P<.10. Only the final model was reported. Since this mixed methods study is explorative rather than hypothesis confirming, we decided to use the threshold value of P<.10. A sensitivity analysis was conducted to determine the robustness of usage thresholds. The sensitivity analysis was performed by changing the threshold of 6 modules to 5 modules (minus 1) and 7 modules (plus 1); this was subsequently repeated in univariate and multivariate analyses. Model fitting was evaluated with the Receiver Operating Characteristic (ROC) curve and the Hosmer-Lemeshow test. Statistical analyses were performed using SPSS Statistics 20.0.

Qualitative analyses

Interviews were analyzed by means of deductive and inductive content analysis [42]. In the deductive approach, a template was created based on three concepts of Eysenbach's law of attrition (relative advantage, complexity, and compatibility) [17]. Guided by these predetermined concepts, text sections were analyzed and coded. In addition to the deductive approach, an inductive method with no predetermined structure was employed. Based on the grounded theory approach [45], recurrent themes from the interview data were identified, coded, labeled, and grouped into broader concepts. While the deductive "top-down" approach tests pre-existing concepts of (non)usage, the inductive "bottom-up" approach starts with patterns observed from the interview data. Data analysis was performed using the software MAXQDA [46] for textual analysis. All interviews were analyzed by the researcher (MB). To assess inter-rater reliability, a random sample of five interviews was analyzed by a second investigator (DB). Codes were compared and disagreements were resolved by discussion between the 2 researchers. No major differences were found in codes between the two researchers.

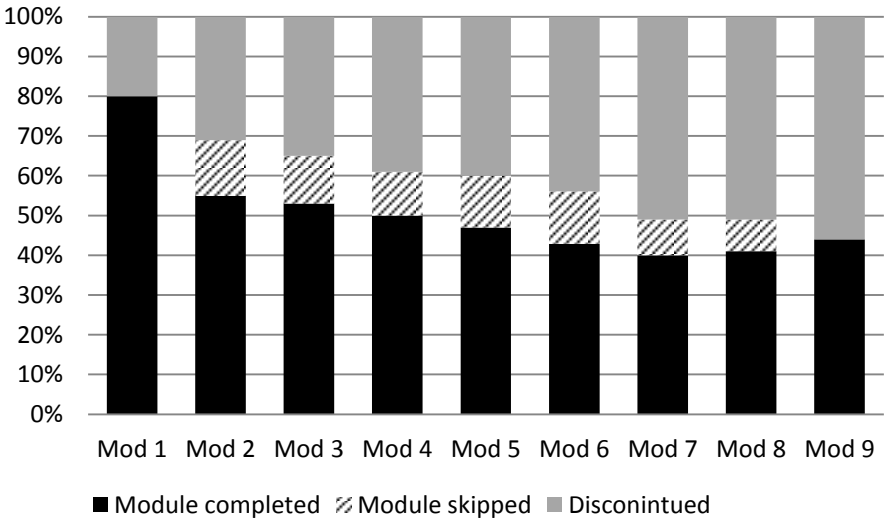
Results

Quantitative results

Program completion

Of the 100 participants who received a password and username to enroll, 49 users made a start with the first module and 6 participants never logged in to their personal website. Figure 2 depicts an overview of the module completion rate; 80% of the subjects completed the first module. This percentage declined to 55% during the second module. Approximately 50 of the 100 users completed modules 3, 4, 5, 6, 7, 8, and 9. The average number of modules completed was 5.6 (SD 2.9) out of 9 modules. Since personal messages were updated on a weekly basis, patients had the opportunity to complete a module within 7 days. Overall, 19 of the 100 participants completed all modules of the program, and 46 of the 100 users used at least 6 out of 9 modules. Consequently, 46 participants were defined as users and 54 as nonusers. Users finished a median of 8 (SD 1.1) modules and nonusers a median of 2 (SD 1.5) modules. Adverse events, such as extreme pain and injuries, were not reported during the program.

Figure 2: Module completion rate



Predictors of program usage

Table 1 presents demographic, clinical, and psychological baseline variables for users and nonusers. Univariate analyses showed that age, BMI, symptoms, and comorbidity reached the threshold of P<.20. Based on these variables, three multivariate models were built, which resulted in the most parsimonious predictors including age and comorbidity (Table 2). Higher age (P=.08, OR 0.94) and presence of comorbidity (P=.02, OR 0.33) were negative predictors for program completion. The sensitivity analysis indicated that the model was robust to changes in the parameter usage. The area under the ROC curve for the model was .68 (95% CI 0.57-0.79). The Hosmer-Lemeshow test of goodness of fit was not statistically significant (P=.43), indicating that the data fitted the model well.

Table 1: Baseline demographic and clinical characteristics

		Users, N=46	Nonusers, N=54	P value
Demographic predictors				
Gender, n (%)				
	Male	17 (37)	23 (43)	.57
	Female	29 (63)	31 (57)	
Age (years), mean (SD)		60 (6.3)	62 (6.5)	.09
Education				
	Lower education	7 (15)	6 (11)	.60
	Middle education	18 (39)	18 (33)	.41
	Higher education	21 (46)	30 (56)	.42
Clinical predictors				
Location OA, n (%)				
	Knee	30 (65)	36 (67)	.89
	Hip	11 (24)	11 (20)	.80
	Both	5 (11)	7 (13)	.64
OA duration (years), mean (SD)		2.8 (1.3)	2.8 (1.1)	.86
BMI (kg/m^2), n (%)				
	Normal weight (<25)	22 (48)	17 (31)	.10
	Overweight (>25)	24 (52)	37 (69)	
Comorbidity, mean (SD)				
	No, n (%)	36 (78)	30 (56)	.02
	Yes, n (%)	10 (22)	24 (44)	
Physical activity		117 (66.1)	130 (65.5)	.29
Pain, 0-10		5.4 (2)	5.4 (2.3)	.92
Fatigue, 0-10		4.7 (2.7)	5.2 (2.8)	.34
Symptoms		56 (15.6)	60 (17.8)	.17
ADL		58.3 (22.3)	55.3 (19.9)	.47
Sport and recreation		58 (22)	55 (19.9)	.47
Quality of life		38.7 (16.9)	42 (17.4)	.32
Psychological predictors, mean (SD)				
Self-efficacy pain		3.4 (0.8)	3.4 (0.9)	.67
Self-efficacy other symptoms		3.5 (0.9)	3.4 (0.9)	.60
Active pain coping		2.0 (0.4)	2.1 (0.4)	.34
Passive pain coping		1.8 (0.4)	1.9 (0.4)	.26
Anxiety		4.7 (3)	4.5 (2.9)	.62
Depression		3.8 (2.9)	3.8 (3)	.88
Internal locus of control		23 (5.4)	23.7 (4.3)	.46
Powerful others locus of control		15.3 (4.4)	15.9 (4.5)	.54

Table 2: Univariate and multivariate analyses for predictors for usage[a]

	B[b]	SE[c]	OR (95% CI)	P value
Univariate analyses				
Age, years	−.06	.04	.94 (0.88-1.01)	.09
BMI (normal weight/overweight)	−.69	.42	.50 (0.22-1.13)	.10
Comorbidity (no/yes)	−.93	.44	.39 (0.14-0.84)	.02
Symptoms (0-100)	−.02	.01	.98 (0.96-1.01)	.17
Multivariate analyses				
Age, years	−.07	.04	.94 (0.87-1)	.08
Comorbidity (no/yes)	−1.1	.46	.33 (0.13-0.82)	.02

[a]The reference groups are nonusage, normal weight, and no comorbidity
[b]B=beta coefficient
[c]SE=standard error

Qualitative results

The qualitative deductive and inductive analysis resulted in the identification of several reasons for (non)usage. The majority of reasons were found by the deductive analysis. Additionally, the inductive analysis identified a number of personal factors (eg, social environment and emotional factors) relating to (non)usage. Reasons are divided into patient, intervention, and study characteristics and are illustrated by interview quotes. Additional quotes illustrative of each theme are provided in Multimedia Appendix 2.

Patient characteristics

Interviewees reported that a low mood interfered with their ability to perform modules. One participant summarized this sentiment by saying, “I had a bad year and I was not at ease with myself. I was not in the right mood to exercise. It was all too much” [woman, hip OA, nonuser]. Lack of self-discipline was another identified reason for nonusage. As one man put it “This kind of program does not work for me. I find it difficult to stay motivated all the time. At the beginning I was motivated but then it went downhill quickly. I got lazy and other activities became more important” [man, knee OA, nonuser]. Another reason for discontinuation was the presence of an additional health problems, other than OA. Due to pain and/or other (medical) treatments, it was difficult for interviewees to continue their involvement in the Join2move program. In addition, participants who

regarded themselves as already physically active found it less necessary to participate. By contrast, patients who felt themselves responsible for their own progress were most likely to use the program. These individuals perceived the program as something that needed to be done, rather than appreciation or enjoyment. Furthermore, those who emphasized the importance of their partner, family, or friends in maintaining the Join2move program were mostly adherent. One participant commented: "Regularly, my husband and friends joined me because I told them about the program. This motivated me to continue" [woman, knee OA, user].

Intervention characteristics

Participants reported that several characteristics of the Join2move intervention were identified as a reason for (dis)continuation. Overall, they expressed positive feedback regarding the complexity of the program. Usability problems with respect to the functionality of the website were not reported. The values "trust" and "reliability" were important in the decision to engage the Join2move program. To cite one patient: "Join2move is based on an evidence-based theory. This persuaded me to participate and to continue with the program" [man, knee OA, user]. Further, patients consistently reported that the Web-based character of the intervention was an advantage compared with face-to-face treatments. The flexibility of being able to complete modules at one's own pace without time or travel restrictions was cited as an advantage. On the other hand, the Web-based character also had a downside. Some participants had a strong need for personal guidance. In the words of one participant: "Although it was possible to fill out an evaluation form about pain and performance, sometimes I just needed a personal chat to talk about my progress" [man, knee OA, nonuser]. Moreover, gradually increasing a self-selected activity was not always compatible with expectations. As one participant said: "I expected a package of specific exercises instead" [woman, knee OA, nonuser].

Study characteristics

Study-related factors were also cited as reasons for remaining or not remaining engaged in the program. Some participants felt under obligation to continue. They described a feeling of commitment to the organizers of the

study. “Because I was allocated to the intervention group, I wanted to finish the entire program. Maybe a little old-fashioned but I found it inappropriate to stop halfway” [woman, knee OA, user]. Some participants perceived the questionnaires used as being too long or too difficult. The questionnaire consisted of 17 pages with a total of 171 items. Participants not only lost interest in completing the questionnaires but were also less motivated to continue with the program.

Discussion

Principal findings

The aim of this mixed methods study was to identify patient, intervention, and study characteristics that facilitate or impede the usage of a Web-based intervention for patients with knee and/or hip OA. Results from this study showed that participants with knee and/or hip OA used the Join2move program less than intended. Of all participants, 94% started the program, 46% reached the threshold of 6 out of 9 completed modules, and 19% finished all 9 weekly modules. To put these rates into perspective, we refer to Hansen et al [7] who found that merely 7% of inactive participants logged in once to a self-guided Web-based PA intervention, and Irvine et al [8] showed that 46% of the users completed all 12 sessions of a self-guided Web-based PA intervention. In a study among patients with rheumatoid arthritis, Van den Berg et al [47] reported that 86% of the patients assessed a website once per week for the duration of 3 months. When considered in light of these studies, our usage rates can be interpreted as reasonable. However, Web-based interventions differ widely in terms of population, content, setting, and methods of measuring usage. For example, while our study used number of modules completed for measuring usage, the above-mentioned studies used log-in data [7,8] or questionnaires [47] as measures. Further, our intervention was self-directed, while the program by Van den Berg et al [47] contained supervision. These differences may have had a major impact on usage and indicates that direct comparison with other reported Web-based interventions remains difficult. In an effort to overcome this issue, the systematic review by Kelders et al [26] adopted the concept of

intended usage. This is a universal measure for adherence, which is defined as the extent to which users should experience the content of the intervention to derive maximum benefit.

Considering the predictors of usage, it appeared from the quantitative analysis that age and comorbidity proved to be significantly related to program usage. Younger participants were more likely to use the intervention modules than older participants. This is in contrast to previous studies that have found correlations between older age and higher usage rates [9,21,22]. This discrepancy in findings can be explained by the fact that the mean age of our study sample was significantly higher (62 years) than the mean age of the other studies (42, 44, and 39 years respectively) [9,21,22]. In fact, the younger participants from our sample should be compared with the older subjects from other studies. This suggests that participants aged roughly 50-60 years are most adherent to Web-based interventions. Apart from this, the presence of an additional medical condition increased the odds of not using Join2move. These results were also confirmed in the interviews. Patients mentioned that physical discomfort during PA and specific comorbid-related factors such as pain, medication use, and disease-related constraints hampered their program performance. Another explanation might be that the program was solely focused on OA and no attention was paid to additional diseases. Participants with an additional illness might feel that the Join2move program did not suit their needs. Unfortunately, it was not possible to examine the influence of each comorbidity on usage due to the low number of cases per disease category. Further research is required to examine which of the comorbidities is most predictive in relation to (non)usage.

With respect to the intervention, participants indicated that the automatic gradual increase of PA as well as working toward a short-term goal were mechanisms that supported them in completing weekly modules. Compared with face-to-face treatments, the flexibility of completing modules at one's own pace without time or travel restrictions was cited as a major advantage. However, older patients, those with comorbidity and patients who attach great importance to personal contact indicated that the lack of human

involvement was a disadvantage. Furthermore, from the interviews it became clear that those who felt themselves responsible for their own progress were most likely to use the program. This, however, was not confirmed in the quantitative analysis. Although we included questions about responsibility and persistence, the questionnaires were not sensitive enough to confirm the conclusions from the qualitative analysis. This illustrates very well why we have chosen dual data collection. The weakness of questionnaires was compensated by interview data. Other mentioned motivations for (non)usage were trial specific. While questionnaires impede usage, commitment to the research team was described as an important facilitator for usage. We did not find any predictive value for education and gender, in contrast to other studies [22,24].

Limitations

A major weakness is the potential presence of recall bias. In an effort to prevent attention bias during the previously conducted randomized controlled trial, the length of time between program participation and interviews was approximately 12 months. As a consequence, participants may not have accurately remembered the intervention in detail. This may have affected the reliability of our results. Another weakness is that results are limited in their generalizability because participants were mainly older, healthy, and highly educated patients with knee and/or hip OA. Furthermore, the role of motivation as proximate determinant of usage behavior was not investigated in this study. Future research should examine the role of motivation on program usage. A last limitation was that participants were included on the basis of self-reported OA. Diagnosis was not confirmed through clinical tests or x-ray reports due to practical reasons. Although self-reported OA is a common inclusion strategy in the field of osteoarthritis research, it is presumable that we have included false positive OA patients in the study.

Future directions and implications

In light of rising health care costs and the large population of patients with knee and/or hip OA, Join2move is an effective, low-cost, and promising program for improving PA levels in patients with knee and/or hip OA. We

believe that the quantitative and qualitative results provide insights that are of relevance to the field of Web-based health education. Future Web-based PA programs should include gradual activity programs with attainable short-term goals. Goal setting, preferably by participants themselves, as well as feedback on performance seem to be powerful tools for increasing the usage of Web-based interventions. Future studies should also pay special attention to older patient groups and patients with a comorbid condition. For these groups a more personal approach is needed. In a further study, we will investigate if guidance by a physical therapist will lead to higher levels of usage. The fact that participants described a feeling of commitment to the organizers of the study may indicate that observed usage patterns cannot be replicated in a real-life setting. Conducting more practically oriented research is an important way to explore usage rates in real-world settings.

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Appendix 1: Interview guide

Introduction

- Tell participants who we are, what Join2move is about and what the aim is of the interview.
- Ask permission for recording.
- Inform interviewees about privacy policy.

Experiences in general

- What is your general opinion about Join2move?
    - How many times did you sign in?
    - Did you visit the website also for another reason than reporting your activities?
        - For example: information/videos
- What did your learn from the program?

Duration of participation

- How long did you participate in Join2move?
    - Why did(n't) you finish the program?
        - Was it difficult to choose an activity?
        - Was it difficult to perform activities ?
        - Was it difficult to perform activities three times a week?
- Which elements did you like?
- Which elements did you not like?
    - What elements of the program can be improved?

Relative advantages

- Why *you* have chosen to participate in this program?
    - Advantages, recommendation to other patients.

Compatibility

Needs/Values

- How does your ideal program looks like?
    - Which elements/characteristics would make the program perfect?
    - Why are these elements/characteristics important for you?

Past experiences

- Did you participate in an physical activity program before?
    - If yes, what are your experiences with this program/therapy?
- Did you participate in an online program before?
    - If yes, what are your experiences?

Complexity

- Did you experience difficulties?
    - Language
    - Tone of texts
    - Functionality
    - Did you use help from others?

Trialability

In Join2move it was not possible to practice before starting.

- Was this a shortcoming?
- Would practicing improve the program?

Observability

- Were other people aware/involved during participation?
- What was the opinion of family/friends/neighbors about your participation in Join2move?
    - Did you receive positive/negative reactions from others?
- Did people notice that you performed more physical activities?

Summary of the interview

Appendix 2: Interview quotes

Patient characteristics

Comorbidity

"A while after registration I began to suffer from tendinitis in my right foot. During the first module the foot was so painful that I decided to quit" [woman, knee and hip OA, non-completer].*" In the year that I registered, I was diagnosed with prostate cancer. I have had surgery and received radiotherapy treatments for several months. Therefore using the Join2move program was too hard for me."* [man, knee OA, non-completer].

Well-being

" I had a bad year and I was not at ease with myself. I was not in the right mood to exercise. It was all too much" [woman, hip OA, non-completer]

Social support

"*My husband and friends joined me regularly because I told them about the program. This motivated me to continue.* [woman, knee OA, completer]

Already physically active

"I have a fulltime job and walk around the office all day. So for me it was not necessary to walk the extra miles for the Join2move program." [man, knee OA, non-completer]

Lack of motivation

"*This kind of program does not work for me. I find it difficult to stay motivated all the time. At the beginning I was motivated but then it went downhill quickly. I got lazy and other activities became more important*. [man, knee OA, non-completer]

Sense of duty

"Although it was a virtual person, I made an agreement and if I make an agreement I stick to it."[man, hip OA, completer]

Intervention characteristics

Trust and reliability

"Join2move is based on an evidence based theory. This persuaded me to participate and continue with the program" [man, knee OA, user]." *The content and feedback of the system was put together well. This made me feel confident that I was in good hands."* [man, knee OA, user].

Usability and complexity

"The language used in the program was easy to understand and appealing" [man, knee OA, non-user]."*Although it was quite simplistic, the structure of the program was an effective and appropriate way to increase my physical activity level"* [man, knee OA, user].

Advantages and disadvantages

"The internet aspect of the program was very convenient. It was not necessary to go out for a weekly appointment. That saved me a lot of time. [woman, hip OA, completer.]

"*Although it was possible to fill out an evaluation form about pain and performance, sometimes I just needed a personal chat to talk about my progress"* [man, knee OA, non-completer].

Expectations about the program

"I expected a package of specific exercises instead of performing 'all day' activities"[woman, knee OA, non-completer].

Study characteristics

Commitment to the researchers

"Because I was allocated to the intervention group, I wanted to finish the entire program. Maybe a little old fashioned but I found it inappropriate to stop halfway. [woman, knee OA, completer]

Questionnaires

"*The questionnaires included too many questions and some questions were hard to answer. Eventually I didn't want to make the effort anymore, so I decided to quit the program."*[woman, knee OA, non-completer].

6

The association between psychological factors and physical activity levels in patients with knee and/or hip osteoarthritis

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Abstract

Background Physical activity and exercise play a crucial role in the management of knee and/or hip osteoarthritis. Although certain psychological factors are regarded as key determinants of physical activity, the relationship between psychological variables and physical activity is rarely studied in patients with knee and/or hip OA. A better understanding of these associations can help in optimizing treatment effects of physical activity interventions.

Objective The aim of this study was to investigate cross-sectional and longitudinal relationships between five psychological factors (pain coping, locus of control, depression, anxiety and self-efficacy) and physical activity in patients with knee and/or hip OA who participated in a web-based physical activity intervention.

Methods This study uses data from a randomized controlled trial that examined the effects of web-based physical activity intervention. A total of 199 participants between 50-75 years of age with knee and/or hip OA were randomly assigned to a web-based intervention (n=100) or a waiting list (n=99). Current study used only data from individuals allocated to the intervention group. Baseline, 3 and 12 months follow-up data were collected to analyze the cross-sectional and longitudinal associations between psychological variables and physical activity. Psychological variables included: pain coping, locus of control, depression, anxiety and self-efficacy. Linear regression analyses were used to calculate cross-sectional relationships and generalized estimating equations analyses were conducted to analyze associations between changes in psychological variables and physical activity.

Results The cross-sectional analyses showed that low levels of passive pain coping at baseline are associated with high levels of physical activity baseline scores (B=-42; P=0.04). Other baseline relationships were not statistically significant. With respect to the 12 month change score associations, increased levels of self-efficacy and decreased internal locus of

control were independently associated with improved levels of physical activity. For each improvement of one point self-efficacy there was an improvement of 15.9 points in physical activity (P=0.01) and an increase of 1 point internal locus of control was accompanied with a reduction of five points in physical activity (P=<0.01).

Conclusion Findings from our study corroborate the important role of self-efficacy in physical activity among patients with knee and hip OA. Although the direction between self-efficacy and physical activity is not clarified, this study suggests that targeting specific elements to increase self-efficacy could have important implications for future physical activity interventions. The finding that increased levels of physical activity were associated with deteriorated levels of internal health locus of control is in contrast to previous studies. More longitudinal research is needed to further explore the underlying causal pathways between psychological variables and change in physical activity intervention outcomes.

Introduction

Osteoarthritis (OA) of the knee and/or hip is a common degenerative disease, affecting 10% of men and 18% of women over the age of 60 worldwide [1]. OA is mainly characterized by pain in the joints and has a major impact on daily life activities such as walking, stair-climbing and gardening [2]. These consequences can greatly impair the quality of life of patients with knee and/or hip OA [3]. Physical activity, including both structured exercises and general lifestyle activities, is the most recommended non-pharmacological treatment in patients with knee and/or hip OA [4, 5]. Evidence has indicated that regular physical activity is important in preserving physical functioning and reducing pain symptoms [6, 7]. Despite recommendations, levels of physical activity in patients with knee and/or hip OA are relatively low compared with the general population [8,9].

In an attempt to enhance a physically active lifestyle in patients with knee and/or hip OA, we developed the web-based program Join2move. The Join2move intervention is based on operant behavior principles to stimulate OA patients to gradually increase their daily life activities in a time contingent way (i.e. on fixed time points), despite potential pain. This is derived from the previously developed and evaluated behavioral graded activity program [10]. In a recent randomized controlled trial (RCT) among199 participants with knee and/or hip OA [11] the Join2move intervention was demonstrated to be effective compared to a waiting list control group. After 12 months, participants in the intervention group reported significantly increased levels of physical activity compared to those who were not exposed to the intervention. Simultaneously with the increase in physical activity levels, we also found positive changes in several psychological factors, including self-efficacy, anxiety and depression. This suggests that a possible link between the improved psychological factors and increased levels of physical activity. Now we do know that the Join2move intervention is effective in the promotion of physical activity, it is interesting to gain insight which psychological factors are associated to this success. If certain psychological factors are associated with physical activity, future interventions can be improved by integrating these factors into their

intervention (e.g. improving self-efficacy if self-efficacy is a factor related to physical activity).

Psychological factors encompass different domains, such as depression, self-efficacy, anxiety and pain-coping. Considerable research among different population groups has focused on the relationship between psychological factors and physical activity e.g. [12]. In particular, the association between self-efficacy and physical activity has been studied extensively [12-15]. This body of research has consistently demonstrated the association between high levels of self-efficacy and high levels of physical activity. Although less conclusive, there is also evidence that other psychological factors such fear of movement, anxiety and depression are negatively associated with physical activity [16,17]. Among persons with knee and/or hip OA, a systematic review reported conflicting evidence regarding the relation between depression and physical activity [18]. Furthermore, a study by Murphy et al. [19] demonstrated that the use of an avoidant coping behavior was associated lower levels of physical activity in patients with knee and/or hip OA.

However, evidence of associations between psychological factors and physical activity in patients with knee and/or hip OA is limited and is derived from predominantly cross-sectional studies. To date, no studies have examined whether modifications in physical activity levels are associated with changes in psychological variables among patients with knee and/or hip OA who participated in a physical activity intervention. Investigating cross-sectional and longitudinal associations may identify psychological factors which are related to physical activity. The identification of these factors could have important implications for future physical activity interventions. The aim of this study was to investigate the cross-sectional and longitudinal relationships between psychological factors and physical activity among patients with knee and hip OA who participated in a web-based physical activity intervention. Instead of establishing the direction of causality, this study investigates the interplay between five psychological factors (pain coping, locus of control, depression, anxiety and self-efficacy) and physical activity.

Methods

Design and procedures

Data from this study were derived from a randomized controlled trial which aimed at evaluating the effectiveness of the Join2move intervention for patients with hip and/or knee OA. In total, 199 eligible participants were randomly assigned either to the Join2move program (n=100) or a waiting list (n=99). Current study only used data from individuals allocated to the intervention group. More information about this study has been published previously [11]. Participants were recruited through advertisements posted in newspapers and health-related websites. Patients were admissible to the study if they met the following criteria: (i) between 50 and 75 years of age, (ii) had self-reported OA in knee and/or hip, (iii) reported an inactive lifestyle (<30 minutes of moderate physical activity less than five days in a week), (iv) had no face-to-face consults for OA with a healthcare provider, other than general practitioner, in the last 6 months, (v) were able to access the internet weekly and (vi) had no contra-indications to exercise without supervision. Once informed consent was obtained, participants were invited to fill out a questionnaire at baseline, 3 months and 12 months. Ethical approval was obtained from the medical ethics committee of the VU University Medical Center Amsterdam. The Netherlands National Trial Register: NTR2483.

The intervention

The Join2move intervention is based on a previously developed and evaluated BGA program for patients with knee and/or hip OA [20]. The BGA program incorporates a baseline test, goal setting, time-contingent physical activity objectives (i.e. on fixed time points) and text messages on the website. An essential component of the BGA program is the positive reinforcement of gradual physical activity, despite the presence of pain. The gradual increase in activities and the achievement of physical activity goals gives patients confidence to increase their physical activity levels, despite potential pain [21]. The Join2move intervention is a fully-automated web-based intervention which contains automatic functions (automatic website text messaging and automatic e-mails) without human support. In the first

week of the program, users select a central activity such as cycling or walking and perform a 3-day self-test and determine a short term goal for the next eight weeks. Based on test performances and a short term goal, eight tailored weekly modules are automatically generated. Every week, new modules are posted on the password-secured website. In addition to the weekly modules, information about OA and lifestyle is provided and videos of exercises are supplemented. At the end of the program, the website presents a motivation message to enhance the performance of regular physical activity in the future.

Physical activity

Self-reported physical activity was measured by the validated physical activity Scale for the Elderly (PASE) [22]. The PASE questionnaire is designed to assess physical activity patterns in older adults. The instrument consists of questions on household, leisure time and work-related activities. Performance of the activities (assigned according to the level of intensity; light, moderate and strenuous) is recorded as never, seldom (1-2 days/week), sometimes (3-4 days/week), or often (5-7 days/week). The amount of time spent in each activity is multiplied by its intensity.

Psychological variables

Anxiety and depression

The degree of anxiety and depression was evaluated by the 14-item hospital anxiety and depression scale (HADS) [23]. The HADS is a fourteen item scale, seven items are related to anxiety and seven are related to depression. A lower score represents less anxiety and depression.

Self-efficacy

Self-efficacy was evaluated by using the Arthritis Self Efficacy Scale (ASES)[24, 25]. For this study we used the subscales self-efficacy for pain and self-efficacy for other symptoms (e.g. fatigue, depression). The score ranges from 1-10, where a higher score indicates greater self-efficacy.

Pain coping

Active and passive pain coping were determined by the Pain Coping Inventory (PCI) questionnaire [26]. This 33-item questionnaire determines active and passive pain coping strategies. A higher score on the active pain coping subscale indicates a more adequate pain coping and a higher score on the passive pain coping subscale indicates inadequate pain coping.

Health locus of control

The believe that health is or is not determined by their behavior (e.g. physical activity) was examined with the Multidimensional Health Locus of Control Scale (MHLC) [27]. In this study, we used two subscales of the MHLC, namely i) belief of control by powerful others (i.e. the responsibility for one's health is assigned to other people, predominantly medical professionals, who are perceived as those in control of one's health condition) and ii) internal locus of control (i.e. the responsibility for one's health is attributed to oneself and to the action one takes with consequences for health). For each subscale a higher score indicates a greater level of belief in a particular subscale.

Statistical analyses

Descriptive statistics were used to describe the main characteristics of the study population. Baseline data were used to perform linear regression analysis in order to examine the cross-sectional relationships between physical activities and psychological variables. We used paired t-tests to examine within-group differences over time. To investigate the longitudinal relationships, change scores were computed for physical activity and psychological variables by subtracting the 3-month scores from baseline scores (T2-T1) and 12-month scores from baseline scores (T3-T1). Subsequently, multiple univariate Generalized Estimating Equations (GEE) were used to analyze the relationship between change in physical activity and psychological variables. The means in change of physical activity between T1 (3 months) – T0 (baseline) and T3 (12 months) - T0 (baseline) was related to the change of the psychological variables. An independent correlation structure was used for the analysis. Given the fact that age [8, 28], education [8], gender [8], comorbidity [29], BMI [28] and location of

OA may influence the variable physical activity, these variables were included as confounders in the analysis. Psychological variables with a p value <0.05 at univariate analysis were subsequently analyzed in multivariate analysis.

Results

Study population

Demographic characteristics and baseline, 3- and 12 month outcomes are depicted in Table 1. Participants were predominantly female (60%), had knee OA (67%), had no comorbidity (65%) and were highly educated (51%). Mean age was 61 years (±SD 5.9) and mean BMI was 27.6 (±SD 4.6). From baseline to 3- and 12 months, statistically significant within-group changes were all in a positive direction, namely lower levels of depression and anxiety scores and improvements in self-efficacy for pain and self-efficacy for other symptoms. The intervention group demonstrated also improvements in physical activity after 12 months. From the 100 participants who completed the baseline questionnaire, 16 were lost to follow-up after 3 months and 24 patients after 12 months. Subjects who did not complete follow-up questionnaires did not differ significantly from those who remained in the study on baseline characteristics (data not shown).

Table 1: Demographic characteristics and baseline, 3- and 12 month outcomes

Outcome measure	Baseline	3 month scores	12 month scores
Gender			
Male. No. (%)	40 (40)	-	-
Female. No. (%)	60 (60)	-	-
Age (years)			
Mean (SD)	61 (5.9)	-	-
BMI (kg/m2)			
Mean (SD)	27.6 (4.6)	-	-
Location OA			
Knee. No. (%)	67 (67)	-	-
Hip. No. (%)	21 (21)	-	-
Both. No. (%)	12 (12)	-	-
Education			
Lower education	13 (13)	-	-
Middle education	36 (36)	-	-
Higher education	51 (51)	-	-
Comorbidity			
None. No. (%)	65 (65)	-	-
1. No. (%)	19 (19)	-	-
≥ 2. No. (%)	16 (16)	-	-
Physical activity (0-400)			
Mean (SD)	123 (64.5)	135 (64.2)	149 (71.0)**
Passive pain coping (0-4)			
Mean (SD)	1.8 (0.35)	1.8 (0.36)	1.7 (0.36)
Active pain coping (0-4)			
Mean (SD)	2.2 (0.34)	2.2 (0.41)	2.2 (0.38)
Internal locus of control (6-36)			
Mean (SD)	21.1 (4.6)	21.4 (4.3)	21.2 (4.7)
Powerful others loc.of control (6-36)			
Mean (SD)	15.5 (4.5)	16.1 (4.5)	14.8 (4.4)
Depression (0-21)			
Mean (SD)	3.7 (2.9)	3 (2.4)*	2.8 (2.5)**
Anxiety (0-21)			
Mean (SD)	4.4 (2.9)	3.8 (2.3)*	3.5 (2.3)**
Self-efficacy pain (1-5)			
Mean (SD)	3.4 (0.85)	3.8 (0.85)**	3.8 (0.9)**
Self-efficacy other symptoms			
Mean (SD)	3.4 (0.9)	3.9 (0.9)**	3.9 (0.7)**

*<0.05 **<0.01 indicates group difference from baseline (paired t test)

Associations between psychological variables and physical activity

Cross-sectional baseline and longitudinal change-score associations between psychological variables and physical activity are presented in Table 2. Results of the cross-sectional analyses showed that low levels of passive coping at baseline are associated with high levels of physical activity baseline scores (B=-42; P=0.04). Other baseline relationships were not statistically significant. With respect to the 3-month longitudinal analysis, the change in psychological variable scores was not associated with change in physical activity. Between baseline and 12 months, however, decreased levels of internal health locus of control and powerful others health locus of control and increased self-efficacy for pain were univariately associated with improved levels of physical activity. In the multivariate analyses, only decreased internal locus of control and increased levels of self-efficacy remained associated with improved levels of physical activity. In this multivariate analysis, for each improvement of one point self-efficacy there was an improvement of 15.9 points in physical activity (P=0.01). Also, the increase of 1 point internal locus of control was accompanied with a reduction of five points in physical activity (P=<0.01).

Table 2: Cross-sectional baseline and longitudinal change-score associations between psychological factors and physical activity

Psychological variables	Cross sectional baseline associations	Univariate longitudinal change-scores		Multivariate longitudinal change-scores	
	Baseline B [95% CI]	0-3 months B [95% CI]	0-12 months B [95% CI]	0-3 months B [95% CI]	0-12 months B [95% CI]
Passive pain coping	-42* [-75.8;-9.1]	16.1 [-6.4;48.6]	-8.6 [-40.2;23.0]	-	-
Active pain coping	-10.5 [-43;22]	-4.9 [-36;26.3]	3.6 [-27.8;34.9]	-	-
Internal HLC	-1.9 [5.1;1.2]	-2.3 [-4.7;0.1]	-4.7** [-7.6;-1.9]	-	-5.0** [-8;-2.0]
Powerful others HLC	-0.7 [-3.5;2.1]	-0.7 [-4.7;3.4]	-3.7* [-6.7;-0.7]	-	-1.5 [-4.4 ;1.5]
Depression	-1.5 [-6.5;3.4]	-1.1 [-5.6;3.4]	-2.8 [-8.4;2.8]	-	-
Anxiety	-2.3 [-6.7;2]	-1.2 [-6.1 ;3.7]	2.3 [-3.3 ;8.0]	-	-
SE pain	4.9 [-9.8;19.6]	-4.9 [-0.6 ;10.7]	12.5* [0.04 ;25.0]	-	15.9** [4.1;27.7]
SE other symptoms	1.8 [-13.2;16.9]	-6.7 [-22.9 ;9.5]	9.6 [-4.6 ;23.7]	-	-

Associations are based on regression coefficients. CI = Confidence Interval; B = Regression Coefficient; HLC = Health Locus of Control; SE = Self-Efficacy. - = variables not significant at univariate analysis and not included in multivariate analysis. For self-efficacy, active pain coping and locus of control a higher score indicates an improvement. For passive pain coping, anxiety and depression a lower score indicates an improvement. Analysis are adjusted for age, education, gender, comorbidity, OA location and body mass index. *= $p < 0.05$;**$p < 0.01$

Discussion

The objective of this study was to investigate cross-sectional relationships and longitudinal change-score associations between psychological factors and physical activity among patients with knee and hip OA who participated in a web-based physical activity intervention program. In accordance with the study by Murphy et al. [19], we found that passive pain coping at baseline was associated with low levels of physical activity. This indicates that those who adopt a more passive coping style are less physically active than those who rely less on a passive coping style. Pain coping refers to the way in which people deal with their pain during all day situations. An

example of a passive strategy would be withdrawing from physical activities to (temporarily) reduce the pain. We only found a cross-sectional relationship between passive pain coping and low levels of physical activity. The reason that we did not observe a longitudinal relationship might be explained by the fact that the grade of passive pain coping did not alter during the 12 month study period.

The previous randomized controlled trial on the effectiveness of Join2move [11] demonstrated long-term (12 month) rather than short term physical activity effects (3 months). In line with that study, current study observed only 12 month change-score associations between psychological factors and physical activity levels. After 12 months, improvements in self-efficacy for pain, 'the belief in one's capability to complete tasks and reach goals' [30], was associated with improved levels of physical activity. This finding is in line with other studies [12, 31] which demonstrated that improved levels of self-efficacy are associated with increased levels of physical activity. From Bandura's theoretical perspective [30], self-efficacy beliefs are determined by four sources of information, namely (i) mastery experience; success when performing a specific task (ii) vicarious experience; influenced by actions from others (iii) verbal persuasion; feedback from others (iv) physiological and affective states; stress levels and negative emotions. Each of these sources provide opportunities to foster self-efficacy. Mastery experience is considered as most influential [30]. One of the best ways to enhance mastery experience is through performance accomplishments. This can be achieved by goal setting, preferably by participants themselves. This is also highlighted in a meta-analysis by Olander et al.[32] in which concrete action planning (when, where and how), realistic, and personally relevant goals were most effective for increasing self-efficacy. In contrast to self-efficacy for pain, we found no relationship between the subscale self-efficacy for activities and physical activity.

We were surprised that deteriorated levels of internal health locus of control were associated with increased levels of physical activity. This relation is difficult to explain. Internal health locus of control, the degree to which people believe that their personal health is controlled by personal decisions,

is usually reported to be associated with more physical activity [33, 34]. However, these previous studies were on cross-sectional relationships rather than change-score associations. More longitudinal research is needed to understand the dynamic relation between physical activity and health locus of control.

While we believe that incorporating strategies to enhance self-efficacy may improve the treatment effects of physical activity interventions, this assumes that the causal pathway is uni-directional and that change in self-efficacy leads to a change in physical activity. However, it is important to note that results from this study do not clarify the direction for causal relationships between psychological and physical activity. Although self-efficacy is generally seen as a determinant of physical activity [32], it is equally possible that relations are bi-directional or that that more physical activity leads to better self-efficacy scores.

In conclusion, although the direction between self-efficacy and physical activity is not clarified, findings from our study underline the important role of self-efficacy in physical activity interventions. Targeting specific elements to increase self-efficacy may help to further improve the outcome of physical activity interventions. More longitudinal research is needed to further explore the underlying causal pathways between psychological variables and change in physical activity intervention outcomes.

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7

General discussion

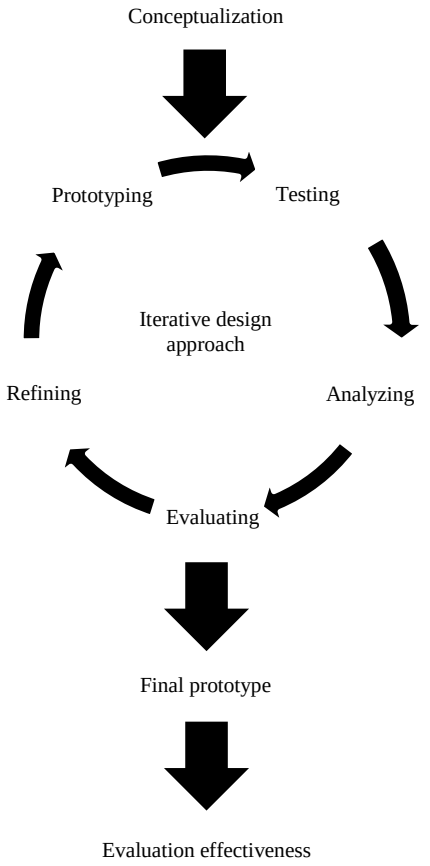
Web-based interventions can be important tools in assisting patients with knee and hip osteoarthritis (OA) to adopt a physically active lifestyle. Web-based interventions have the potential of high reach, low costs and are 24/7 accessible from anywhere. We therefore developed the web-based intervention Join2move that provides a highly individualized behaviorally based physical activity program for patients with hip and/or knee OA. The intervention is unique, since this is the first web-based physical activity intervention focusing on patients with knee and hip OA. To investigate whether Join2move was effective in terms of physical functioning and physical activity, a randomized controlled trial was conducted. In this final chapter, results from the previous five chapters will be discussed in view of other research. This chapter will also address the methodological considerations, clinical implications and suggestions for future research.

Development process Join2move

Although there is an increasing body of research focusing on the effectiveness of web-based interventions, less attention has been paid to the development of these technologies. The majority of web-based interventions is created through ad-hoc procedures without involvement of structural approaches and user centered designs [1]. This lack of rigid structure in design seems to be one of the main reasons why web-based interventions do not reach their full potential in terms of adherence and outcomes [2, 3]. For the development of Join2move, we incorporated a structural iterative design methodology [4] to test, analyze and refine the program (Figure 1). This means that each step of the development process was based on the knowledge from earlier steps. End-users (i.e. patients with knee and/hip OA) were involved continuously throughout the developmental process. This bottom-up approach captured important information about user needs and usability issues which were important for the refinement of Join2move. For example, users indicated that the inability to repeat modules was frustrating. We therefore have changed the program into a more flexible format which provides users the ability to repeat and/or adapt the difficulty of weekly modules. Based on a literature search on effective web-based components and the core elements of the behavioral graded activity program, a first concept of the Join2move intervention was developed. With this concept in

mind, several cycles of testing (including a focus group, pilot study, interviews, thinking aloud approach and a heuristic evaluation) were performed. Eventually, this led to the final version of Join2move. Although such comprehensive process is time-consuming, it brought us a worthy and user friendly product. It is crucial that researchers allow sufficient time and budget for the development process of web-based interventions. An overview of our one-year development process is presented in figure 1 and may be used as example for other researchers and developers for the development of web-based interventions.

Figure 1: Project overview



Effectiveness of web-based interventions

Web-based interventions have increasingly been used to improve physical activity in patients with a chronic disease. This thesis includes a systematic review of the literature in which the effectiveness of web-based interventions in patients with a chronic disease is summarized (chapter 2). At the time of inclusion, only seven studies fulfilled the eligibility criteria. The best evidence synthesis revealed conflicting evidence on the effectiveness of web-based physical activity interventions in patients with a chronic disease compared to no interventions. Three high quality studies reported significant effect sizes in favor of the intervention groups, whereas two high and two low quality studies did not reach statistical significance. The literature search for this review was conducted in the spring of 2011. Meanwhile, from the time of inclusion until now, more randomized controlled trials (RCTs) of web-based interventions were published or are ongoing [5-8]. After a quick scan, we found two recent publications [5,7] which showed that web-based programs are effective in the promotion of physical activity in patients with coronary heart disease and diabetes. The study by Glasgow [5] is a follow up on an earlier study [9] which was also included in our review. The study reveals that the 12-month effects were less pronounced than the short-term effects. This finding, together with the results of other studies [10-12], suggests that beneficial effects of web-based interventions are not maintained in the long term. Recent publications and ongoing research illustrate the growth of web-based interventions in the last three years. It is therefore likely that in a few years researchers are able to conduct a meta-analysis for a more comprehensive analysis of web-based physical activity interventions in patients with a chronic disease. With the increase in web-based studies, future systematic reviews have also the ability to focus on specific patient groups (e.g. patients with diabetes, osteoarthritis or coronary heart disease). This is important since each particular disease affects physical activity behavior in another way which results in distinction between interventions. To illustrate, while physical activity interventions for patients with arthritis focus on pain as potential barrier for physical activity [13,14], interventions for patients with diabetes perceive address fear of a hypoglycemia and incorporate blood sugar management to induce higher levels of physical activity [15, 16].

It was remarkable that in most studies the intervention was insufficiently described and documented in terms of content and that the measure for program adherence (e.g. number of modules completed or login-data) was not reported. These omissions raises several problems for other researchers and clinicians. First, the lack of precise content makes it impossible to determine which elements of web-based interventions are most successful in the promotion of physical activity. Second, the lack of information hampers the conceptualization of new interventions. Third, researchers are unable to compare web-based interventions and are unable to replicate research findings. Fourth, clinicians do not know how to deliver web-based interventions to their patients. For these reasons, initiatives to improve intervention description in the field of eHealth are needed. The consort of statement for eHealth [17] is such an initiative which can be applied to provide guidance on how eHealth trials should be reported. This guideline contains twelve intervention items, such as the description of the development process, content, usage parameters clarifications on the level of human involvement. In future research, investigators should use this consort-eHealth to enhance the reproducibility of successful web-based interventions.

Feasibility and usability of Join2move

As part of the iterative design process (figure 1), we performed a pilot study and two usability tests before the Join2move program was investigated through an RCT (chapter 4). The feasibility was tested in a non-randomized pilot study among 20 patients with hip and/or knee OA. The results suggested that the Join2move intervention was feasible and promising in the promotion of physical activity among inactive patients with knee and/or hip OA. In addition to the pilot study, we conducted two well-known usability evaluation methods, namely a heuristic evaluation and a thinking aloud approach. These usability tests provided important insights concerning the layout, navigation and functionality of Join2move. According to Eysenbach's law of attrition [18], these usability factors are important preconditions for program adherence and study continuation. We exposed several usability issues throughout the usability testing process. The heuristic evaluation with usability experts encountered problems related to the

functionality of the program. Based on these results, we changed the program's time contingent structure (i.e. fixed time periods) into a more flexible format. The usability errors from the thinking aloud approach had more to do with the design of the website and the location of several buttons. These relatively minor problems were also addressed and solved in the final version of Join2move.

The results from a randomized controlled trial

Effectiveness

Eventually, the iterative design approach led to a final version of the Join2move intervention. To evaluate short- and long-term effectiveness of this final version, a randomized controlled trial was designed. Patients in the intervention group were granted access to Join2move in order to use the program for nine consecutive weeks while participants in the control group received no intervention. Participants were recruited through advertisements in Dutch newspapers and online health-related websites. The main inclusion criteria were: 1) age between 50 and 75 years, 2) self-reported OA in knee and/or hip, 3) self-reported inactivity (<30 minutes of moderate physical activity three or five times or less per week) and 4) no face to face consults for OA with a healthcare provider, other than GP, in the last 6 months. A detailed description of the trial, which ultimately involved 199 patients, is presented in chapter 4. Results of the trial showed that Join2move was effective. After 3 months, participants in the intervention group reported a significantly improved physical function status, a positive self-perceived effect, lower pain and fatigue levels and better self-efficacy scores compared to patients in the control group. At 12 months, the intervention group reported higher levels of both subjective (PASE questionnaire) and objective physical activity (ActiGraph GT3X) and also reductions in tiredness, anxiety and passive pain coping compared with the control group.

Contrary to our expectations, improved levels of physical activity were not accompanied with improved levels of physical function. Two previous studies have demonstrated [19, 20] that more daily physical activities are associated with improved physical function in patients with knee

osteoarthritis. It must be noted that these two studies observed only significant associations between physical activity and objective measures of physical function. As in our study, correlations between physical activity measurements (PASE and accelerometer) and subjective physical function (WOMAC) were poor. Although a definitive explanation of the non-existent relation between physical activity and physical function remains unclear, at least one explanation is possible. In our study we used the PASE questionnaire to assess physical activity. The PASE questionnaire is not designed to report physical activity intensity levels [21]. Since the Join2move promotes mainly activities such as walking and cycling, it may be possible that the questionnaire was not sensitive enough to detect changes in these moderate intensity activities. This might explain why changes in physical activity were not parallel to changes in subjective physical functioning.

An interesting question is how our findings relate to other trials in the field of web-based physical activity promotion. Self-reported and objectively measured long term effect sizes were respectively 0.18 and 0.20 and roughly consistent with previous RCT studies investigating the effects of internet-based physical activity interventions. Although these reviews did not specifically focus on chronic diseases, they found effects sizes of 0.44 [12] and 0.14 [10]. The systematic review in patients with a chronic disease (chapter 2) also reported similar effect sizes (d=0.13-0.56) [22]. When considered in light of these studies, our long-term effect sizes correspond reasonably well. However, direct comparison of effect sizes remains difficult since web-based interventions differ widely in terms of population, content and setting. For example, while our intervention was self-directed without human involvement and focusing on patients with knee and hip OA, most interventions contain human supervision with a focus on healthy people. It is well known that characteristics related to the participant, intervention and study may have an impact on the adherence and corresponding effect sizes [18,23,24].

Since long-term follow-up studies demonstrated that effects of interventions are not sustained in the long term [10-12], we expected short-term rather

than long-term physical activity effects. Surprisingly, we found only long-term effects in total physical activity scores. These results were confirmed by both self-reported and accelerometer data. A definitive explanation for the non-significant short-term differences remains unclear. However, the absence of short-term effects can partly be explained by improved self-reported physical activity outcomes in the control group. The potential presence of the so-called 'Hawthorne effect' may have contributed to high physical activity scores in the control group. Selective dropout, which may have enhanced the effects in the control group, was not found.

Adherence and reasons for non-usage

Non-adherence refers to the issue that not all participants use or continue using web-based interventions in the desired way. Since participation in fully automated web-based interventions requires active involvement, the issue of non-usage is a frequent phenomenon in this field [18, 25]. Unfortunately, this was no exception for Join2move. Of all potential users, 94/100 participants actually started the program, 46/100 reached the adherence threshold of six out of nine modules completed, and only 19/100 finished all nine week modules. In light of other studies, these adherence rates can be interpreted as average. In previous research, Hansen et al. [26] reported that only 7% of inactive participants logged in once to a self-guided web-based physical activity intervention and Irvine et al [27] showed that 46% of the users completed all 12 sessions of a self-guided web-based physical activity intervention. Given the substantial observations of non-usage, a relevant question is why participants discontinue. Gaining more insight into factors which influence adherence is important to enhance program usage and helps us to make web-based interventions more effective. To answer abovementioned question, we conducted a mixed methods study involving both qualitative and quantitative data collection and analysis (chapter 4). In this mixed methods study we found several patient, intervention and study factors which were important for the adoption of Join2move. Consistent with other studies [28-31], the mixed method study demonstrated that older participants with co-morbidities are less adherent to web-based interventions than younger individuals without additional health problems. At least two explanations for this finding can be considered. First, patients indicated that

physical symptoms (e.g. pain) and other co-morbid related factors (e.g. medicines) affected their exercise performance in a negative way. As a consequence, they were less motivated to continue with the Join2move program. Second, in general, older age groups have lower levels of eHealth literacy (e.g. poor skills and eHealth self-efficacy) than younger people [32]. This may also have contributed to poor levels of adherence in this particular group. The results from the interviews showed that those with a high self-discipline were most likely to use the program. In addition, trust in the program, social support from family or friends and commitment to the research team were important factors in encouraging users to persevere with Join2move. In the contrary, lack of personal guidance during the program and physical discomfort during physical activity were factors that influenced adherence negatively. These results suggest that Join2move may be of most relevance and utility to those who feel responsible for their own disease are in the mid-to-older age group and do not have additional co-morbidities which hinder the performance of physical activity.

Psychological working mechanisms

Now that we know that the Join2move intervention is effective in the long-term promotion of physical activity, the question arises which factors may have contributed to this success. Chapter 6 of this thesis investigated the cross-sectional and longitudinal associations between psychological factors and physical activity. The longitudinal analyses from 100 participants who received the Join2move intervention suggested that self-efficacy is a relevant determinant of physical activity behavior change. Improvements in self-efficacy, 'the belief in one's capability to complete tasks and reach goals' [33], was associated with improved levels of physical activity. These findings are in line with other studies [34, 35] which show that, in order to increase physical activity, it is an important to increase self-efficacy. Therefore, it seems reasonable to target self-efficacy in order to change physical activity behavior.

Bandura argued that the strongest source of self-efficacy is the individual's own previous experience with physical activity [33]. This theory is supported by a meta-analysis showing that programs which include concrete

action planning for short-term, realistic, personally relevant and enjoyable physical activity are most effective for changing self-efficacy [36]. These behavior change techniques are also found in the behavioral graded activity theory, which was the theoretical framework of the Join2move intervention. In the graded activity theory the experience of success in physical activity is stimulated through the gradual increase of physical activity towards a preset goal. Patients start with a low level of physical activity which ensures success during the initial sessions of the Join2move program. This may have led to the increase of confidence and improved levels of physical activity in the patients who participated in the Join2move program. However, for a definitive answer, more research is needed to explore which specific elements are responsible for the enhancement of self-efficacy.

Methodological considerations

A randomized controlled trial was chosen to investigate the effectiveness of Join2move. A randomized controlled trial is considered as the strongest and most appropriate design to evaluate interventions. We also had to deal with methodological issues which may have affected the quality of the study. A first limitation is that we included participants based on self-reported OA. Unfortunately, due to practical constraints, diagnosis was not confirmed through clinical tests or X-ray reports. However, in the pilot study (chapter 3) we verified self-reported OA through clinical tests. According to the American College of Rheumatology criteria [37, 38], 80% of the participants had clinical knee or hip OA and 20% had no OA. These rates are in line with another validation study [39] reporting over 80% agreement between self-reported and clinically confirmed diagnoses. Although these rates are acceptable, it is presumably that we included false positive OA patients in our trial. A second limitation concerns the external validity of the study due to the self-selected sample. Patients were recruited through advertisements in newspapers and health related websites. Typically, responders were predominantly healthy and highly educated patients. This widely recognized phenomenon is called the “The inverse information law” [40]. Web-based interventions, as other lifestyle changing interventions, fail to reach those whom physical activity behavior changes are most necessary. Therefore, future web-based studies should search for strategies to reach and recruit

inactive patients with a low socioeconomic status. A third limitation involves the high drop-out attrition rates in the RCT study. At the end of the 12-month research period, 25% of the participants dropped out of our study. The response rates were not different between the two groups. Overall, drop-out attrition is commonly experienced in randomized controlled studies. Our drop-out attrition rates are in accordance with the study by Glasgow et al. [5], who reported a general drop-out rate of 25.5% after 12 months. Commonly, these drop-out rates are accompanied with non-usage attrition [41]. This was also the case in our study where 4/46 adherent and 26/54 non-adherent persons did not return one of the follow-up surveys. A fourth limitation concerns the fact that interviews for the mixed method study took place 12 months after study enrollment. As a consequence, participants may not have accurately remembered the intervention in detail which may have affected the reliability of our results.

Implications for clinical practice

Supported by the Ministry of Health, Welfare and Sport [42], eHealth is seen as an important technological tool to enhance self-management. eHealth interventions, such as Join2move, are promising to empower patients to take a proactive role in the management of their disease. However, its success is lagging behind expectations. In practice, patients and healthcare providers rarely use eHealth interventions [43]. There is little awareness among patients and healthcare providers that ICT technologies can enhance self-management. A better integration of eHealth in standard treatment regimens could lead to greater awareness which eventually may lead to increased use in daily practice.

For a successful continuation of Join2move, integration into the standard care of patients with knee and hip OA is needed. In The Netherlands, general practitioners (GPs) are considered as a first and main point of contact for people with knee and/or hip OA. So, the non-surgical treatment generally takes place within primary care. In 2011, Smink et al. [44] published a stepped-care strategy that offers health professionals and patients structure in the non-surgical management of knee and hip OA. This approach, also known as the BART strategy, comprises three steps. When we focus only on

the treatment modalities, the first step includes education and lifestyle advise to all patients with knee and hip OA. The second step is a bit more intensive and comprises exercise therapy and weight reduction for obese patients. In the third step more advanced treatment options are considered, such as multidisciplinary care and transcutaneous electrical nerve stimulation (TENS) techniques. Join2move is an excellent tool which can be adopted in the initial phase of this stepped care strategy (Table 1). Join2move offers healthcare professionals an alternative option in the promotion of lifestyle advice and education. Results from a recently conducted survey among 800 GPs showed that GPs do not have suitable materials and are often too busy to engage in physical activity promotion [45]. So, since there is a need for self-help education materials such as Join2move, integration in the general practice seems to be promising. Before a broader implementation takes place, the cost-effectiveness and practical feasibility in routine primary care should be investigated.

Table 1: Stepped-care modalities for the management of knee and hip OA, adapted from the study of Smink et al.[44]

Step 1	Step 2	Step 3
Education Lifestyle advice	Exercise therapy Dietary therapy	Multidisciplinary care TENS
Medication • Acetaminophen • Glucosaminesulphate	Medication • NSAIDs • Tramadol	Medication • Intra-articular injections

Integration Join2move

Future research

Based on the findings of this thesis, several recommendations for future research can be made. The effectiveness of Join2move was investigated in an RCT. Although the design is highly suitable to assess clinical efficacy, an RCT may not be the best setting to evaluate adherence rates of web-based

interventions. In accordance with others [25,46,47], interviews in this thesis (chapter 5) suggest that certain study related factors, such as attention and commitment to researchers, are positively related to the adherence of web-based interventions. As a result, the observed usage patterns may not be translated to the real world setting and effectiveness may be overestimated. In order to generalize findings to real situations, future research should explore usage rates in a more natural testing environment, such as living labs. It would also be valuable to compare public registrants with trial participants. After the inclusion period, more than 200 people registered themselves for participation in the Join2move intervention. These public registrants were not included in the RCT study. Because the use of web-based interventions in a trial context may not reflect the use of interventions in an open access context, it will be interested to compare these public registrants with the trial participants in a future study. Another important direction for future research is to identify intervention strategies to strengthen adherence of web-based interventions. Goal setting, preferably by participants themselves, as well as feedback on performance seem to be powerful tools for increasing the usage of web-based interventions. Another direction for future studies is to investigate the combination of online and face-to-face care, referred as 'blended-care'. In a new research project, we will integrate Join2move into the physical therapy practice in which a part of the physical therapy sessions will be substituted by a website. The primary aim of this study is to investigate the cost-effectiveness of this 'blended-care' intervention. It is expected that this new intervention is cost-effective compared to traditional physical therapy in patients with knee and hip OA. As a last point for future research, we recommend that researchers allow sufficient time and budget for the development process of web-based interventions. The success of many interventions is hampered by poor adoption rates and implementation failure in practice. This can be attributed to insufficient attention to the development process. It is therefore of vital importance that researchers should apply user centered iterative strategies to create better designed programs. One of such iterative strategies, which emphasizes the involvement of stakeholders in the development process, is the CeHRes Roadmap [48]. The CeHRes model is a practical guideline

which consists of persuasive technology theories, human centered design approaches and business modeling.

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Summary

As described in **chapter 1**, knee and hip osteoarthritis (OA) is a common disease of the joints. The risk of osteoarthritis increases with age. In OA, the cartilage in the joint becomes thinner and softer. Moreover, other structures in and around the joint, such as the subchondral bone compartment, synovial membrane, ligaments and muscles may also be affected. These modifications within and around the joint may lead to a gradual development of clinical symptoms, such as joint pain, joint stiffness and muscle weakness. OA is mainly characterized by pain. As pain progresses, patients begin to have difficulties with daily life activities. Generally, the pain increases during weight-bearing activities, such as walking and stair-climbing. Due to pain and other symptoms, many patients may tend to avoid physical activities on a structural basis. These patients misinterpret pain sensations as a sign of joint damage and believe that more physical activity leads to more pain. In the short term, the avoidance of activities may lead to less pain. However, in long term, physical inactivity may lead to deterioration of physical (e.g. muscle weakness, decreased physical capacity) and psychological health (e.g. reduced confidence, anxiety) and eventually to functional decline. Consequently, these limitations can lead to further avoidance of activities and more pain.

National and international guidelines underline the importance of physical activity in patients with knee and/or hip OA. First, regular physical activity has positive effects on general physical and mental health. Second, research has indicated that sufficient physical activity positively impacts the function status and pain levels in patients with knee and hip OA. These effects have been demonstrated for moderate intensity activities, such as walking, cycling and swimming. In contrast to these recreational activities, intensive physical activities, such as jumping and running, may strain the joint. These activities may have an adverse effect on the joint and are not recommended.

Despite positive effects of regular physical activity, people with knee or hip OA are less physically active than people without OA. Therefore, the promotion of physical activity is an important pillar in the management of knee and hip OA. There are multiple methods to promote physical activity, such as specific exercises and recreational physical activity programs. Since

the popularity of internet has grown significantly over the past 10 years, the world wide web has created new alternatives for the promotion of physical activity. Today, a considerable amount of websites, apps and social media promote physical activity in many different ways. These initiates are generally referred as ‘eHealth’. eHealth is 24/7 available and a large number of people may be reached for relatively low costs. Given these specific advantages, the internet is already considered as one of the most important vehicles to promote a healthy lifestyle, including physical activity.

In the Netherlands, the vast majority of patients are not in treatment for their OA related problems. However, many of these so called ‘outside care patients’ suffer from consequences of their disease and need adequate information and help to remain physically active. The internet offers a viable way to deliver self-help interventions to assist outside care patients in achieving higher levels of physical activity.

Join2move

As far as we know, Join2move is the first web-based physical activity intervention for patients with knee and/or hip OA. Join2move focuses on physically inactive people with knee and/or hip OA who are not being treated by a healthcare professional. The program is provided through the website www.artroseinbeweging.nl. Every week, for nine executive weeks, participants receive assignments in which a self-chosen activity, such as cycling or walking, is gradually increased. The gradual increase of activities is based on the behavioral graded activity treatment. The behavioral graded activity treatment is a form of exercise therapy that utilizes a time-contingent method to increase patients’ activity level, despite the potential presence of pain. The gradual increase in activities aims to change the perception that physical activity is related to pain. The ultimate goal is that patients integrate more physical activities in their daily lives and maintain higher levels of physical activity over time. In addition to the physical activity assignments, the program provides videos of strength and mobility exercises and information about pain, medicines, OA etc.

In this thesis the following five research questions were addressed:

- What is the effectiveness of existing web-based physical activity interventions in patients with a chronic disease? (chapter 2)
- What are the preliminary results and experiences of end-users with the Join2move program? (chapter 3)
- What is the effectiveness of the Join2move program in patients with knee and/or hip osteoarthritis? (chapter 4)
- Which factors have an influence on the usage of the Join2move program in patients with knee and/or hip osteoarthritis? (chapter 5)
- What is the relationship between psychological factors and physical activity in patients with knee and/or hip osteoarthritis? (chapter 6)

A systematic review of literature

Chapter 2 presents the results of a systematic review on the effectiveness of web-based physical activity interventions in adults with a chronic disease. A comprehensive search was executed in different internet databases. Articles were included if they involved: (1) participants with a chronic disease; (2) a web-based physical activity intervention and (3) a control group that was not exposed to any treatment or intervention. Ultimately, five high and two low quality studies met the eligibility criteria. The results of the seven studies were summarized and showed conflicting evidence on the effectiveness of web-based physical activity interventions in patients with a chronic disease. In conclusion, it remains unclear whether web-based interventions can influence physical activity behavior of patients with a chronic disease. More research is needed to determine the actual impact of web-based physical activity interventions in patients with a chronic disease.

The preliminary effectiveness and usability of Join2move

Chapter 3 describes the design, performance and preliminary results of a non-randomized pilot study. Twenty patients with knee and/or hip OA participated in the pilot study and followed the Join2move program. Primary outcomes were physical activity and physical function. Baseline, 6 and 12 week follow-up data were collected via online questionnaires. The results showed that after the intervention period participants were more physically active. After 6 and 12 weeks, the total minutes spent on physical activity

increased with respectively 24% and 20% compared to baseline values. With respect to physical functioning, within group differences were smaller and not statistically significant. After the pilot study, interviews and two usability tests were conducted. The interviews were focused on users' experiences with the Join2move intervention. In the usability tests, users were asked to verbalize thoughts during the execution of multiple tasks and software experts examined the website through a set of usability criteria. We captured several usability issues throughout the usability testing process. Participants rated the rigid character of the intervention as a disadvantage. Supported by these results, we changed the program's time contingent structure (i.e. fixed time periods) into a more flexible format. Overall, findings from the interviews and usability tests showed that the program was easy to use and the user satisfaction was high.

The effectiveness of Join2move

Chapter 4 reports the findings of a randomized controlled trial investigating the effectiveness of the Join2move intervention in patients with knee and/or hip OA. Participants were recruited through an appeal in the newspaper Noordhollands Dagblad, articles in several local newspapers and advertisements on websites. Participants were included if they met all of the following inclusion criteria: (1) aged 50-75 years, (2) self-reported knee and/or hip OA, (3) self-reported inactivity (30 minutes of moderate physical activity, 5 times or less per week), (4) no face-to-face consultation with a health care provider other than general practitioners for OA in the last 6 months, (5) ability to access the internet weekly and (6) no contra-indications to exercise without supervision. Eventually, 199 participants with knee and/or hip OA were randomly assigned to the Join2move-group (n=100) or the waiting list control group (n=99). People allocated to the control group received no treatment. The primary outcome measures were physical activity, physical functioning and self-perceived effect. Outcome measures were collected before randomization, after 3- and 12 months.

Both short (3 months) and long term (12 months) results demonstrated statistically significant improvements in favor of the intervention group. This means that differences found between the two groups are not a result from

chance but likely the result of the Join2move intervention. After 3 months, patients who participated in the Join2move program reported a significantly improved physical function status in comparison to those in the control group. Daily life activities, such as stair climbing, squatting, walking and shopping, improved significantly. Moreover, after 3 months 44% of the participants in the intervention group reported improvements in self-perceived effects. In comparison, only 7% of the control group reported self-perceived improvements with respect to their knee and/or hip OA. No differences between the groups were found with respect to the outcome measure physical activity. After 12 months, the intervention group showed higher levels of physical activity compared with the control group. No effects were found for the outcome measures physical function and self-perceived effect.

In contrast to our initial expectations, higher levels of physical activity were not accompanied with improved levels of physical function. We know from previous research that more daily physical activity is associated with improved physical function in patients with knee and/or hip OA. Although a definitive explanation for our discrepant findings remains unclear, it is possible that the questionnaire used in our study was not sensitive enough to detect changes in moderate recreation activities. This might explain why changes in physical activity were not parallel to changes in physical functioning.

The adherence to Join2move

Chapter 5 presents the results of a mixed methods study. In this study both quantitative and qualitative methods were used to identify factors that influenced the usage of the Join2move intervention. More insight in these factors is a necessary step toward enhancing the usage of the Join2move program. This study used data from the 100 individuals allocated to the intervention group. Data from participants allocated to the control group were not used. For the quantitative part, demographic-, clinical- and psychological variables were used to build a multivariate prediction model. With respect to the qualitative methods, semi structured interviews were conducted.

In light of other studies, the adherence rates can be considered as average. Of all 100 participants who received a password and username, 46 completed at least six out of nine modules (user group). The other 54 participants (non-user group) completed less than six modules. In this mixed methods study the user and non-user group were compared to each other. Multivariate regression analyses revealed that higher age and presence of comorbidity predicted non-usage. Results from the interviews showed that a lack of personal guidance, presence of physical problems and low mood were barriers for the usage of Join2move. In addition, the absence of human involvement was mentioned as a disadvantage and negatively impacted program usage. Factors that influenced usage positively were the reliability of the intervention, convenience of the intervention, social support from family and/or friends and commitment to the research team. Although the self-guided components offer several advantages, particularly in relation to costs, reach, and access, we found that older patients and participants with a comorbid conditions need a more personal approach. For these groups a blended form of Join2move -combination with face-to-face guidance- in the health care environment seems to be promising.

Relationship between psychological factors and physical activity

Chapter 6 is a study on the cross-sectional and longitudinal relationship between psychological factors and physical activity in patients with knee and/or hip OA. In this study we used the baseline, 3 and 12 month measurements of the intervention group (see chapter 4). The five investigated psychological variables were pain coping, locus of control, depression, anxiety and self-efficacy. The cross-sectional analyses (i.e. analyses at one point in time) showed that low levels of passive pain coping at baseline were associated with high levels of physical activity baseline scores. Other baseline relationships between physical activity and psychological variables were not statistically significant. The longitudinal analyses (i.e. analyses at different points in time) revealed that increased levels of self-efficacy and decreased internal locus of control were independently associated with improved levels of physical activity. The findings of chapter 6 corroborate other research which indicate that self-efficacy has an important role in increasing physical activity levels.

Although the direction between self-efficacy and physical activity is not clarified, this study suggests that targeting specific elements to increase self-efficacy could have important implications for future physical activity interventions for patients with knee and/or hip OA.

Discussion

Chapter 7 discusses the results and conclusions of this thesis. Furthermore, methodological considerations are discussed and recommendations for clinical practice are given. Finally, we end up with a section with suggestions for future research. The research conducted in this thesis has proved that the Join2move program is effective in the promotion of physical activity in patients with knee and/or hip OA. Join2move seems especially suitable for the initial step in the non-surgical treatment of knee and/or hip OA. Since there is a lack of effective self-management materials, Join2move offers healthcare professionals an excellent tool to promote a physically active lifestyle in patients with knee and hip OA.

A major strength of this thesis is that we employed a randomized controlled trial to investigate the effectiveness of the Join2move intervention. However, this thesis also has certain limitations. A first limitation is that we included patients based on self-reported OA. It is therefore presumable that we included false positive OA patients in our study. A second weakness concerns the external validity of the study. In general, participants were healthy and highly educated patients with knee and/or hip OA. This may have reduced the generalizability of the study findings. To address this limitation, future research should search for strategies to recruit lower educated people with an unhealthy lifestyle.

Samenvatting

Zoals beschreven in **hoofdstuk 1** is knie- en heupartrose een veel voorkomende gewrichtsaandoening. Het risico op artrose neemt toe naarmate men ouder wordt. Bij artrose wordt het kraakbeen in het gewricht dunner en zachter. Daarnaast treden veranderingen op in het bot, gewrichtskapsel en omliggende spieren. Door deze veranderingen in en rondom het gewricht kunnen mensen met artrose klachten ervaren, zoals gewrichtspijn, gewrichtsstijfheid en spierzwakte. Artrose wordt voornamelijk gekenmerkt door pijn. Deze pijn kan lijden tot beperkingen in het dagelijks leven. Doorgaans neemt de pijn toe tijdens fysieke activiteiten, zoals traplopen, knielen en langdurig wandelen. Door deze toename in pijn tijdens bewegen is er een grote groep mensen met knie- en heupartrose die fysieke activiteiten vermijdt. Dit komt omdat deze mensen de gedachte hebben dat bewegen de pijn en artrose verergert. Op korte termijn resulteert het vermijden van activiteiten inderdaad tot minder pijn. Echter, op lange termijn kan het structureel vermijden van fysieke activiteiten zowel fysieke (zoals verminderde mobiliteit, spiekracht en fitheid) als psychologische (zoals minder vertrouwen) consequenties hebben waardoor de pijn juist kan toenemen.

In nationale en internationale richtlijnen wordt het belang van fysieke activiteit bij knie- en heupartrose benadrukt. Ten eerste heeft regelmatig bewegen positieve invloed op de algemene fysieke en mentale gezondheid van mensen. Ten tweede heeft onderzoek aangetoond dat een fysiek actieve leefstijl pijn en beperkingen bij artrose kunnen verminderen. Dit effect is aangetoond bij matig intensieve activiteiten, zoals wandelen, fietsen en zwemmen. In tegenstelling tot deze recreatieve activiteiten kunnen bepaalde zware (schok)belastende activiteiten, zoals springen en rennen, het gewricht juist overbelasten. Deze activiteiten kunnen negatieve invloed hebben op het klachtenpatroon van mensen met knie- en heupartrose en worden daarom niet aanbevolen.

Ondanks positieve gezondheidseffecten bewegen mensen met knie- en heupartrose minder dan mensen zonder artrose. De promotie van fysieke activiteit is daarom een belangrijke pijler in de behandeling van artrose. Er

zijn verschillende manieren om fysieke activiteit te stimuleren, bijvoorbeeld middels specifieke oefeningen en beweegprogramma's. Met de toename in gebruik van internet in de afgelopen tien jaar worden beweegprogramma's steeds vaker online aangeboden. Tegenwoordig is er een overvloed aan websites, apps en sociale media die op een of andere manier het beweeggedrag kan stimuleren. Dit wordt vaak aangeduid met de overkoepelende term 'eHealth'. Het gebruik van eHealth heeft een aantal voordelen. eHealth is 24 uur per dag beschikbaar en heeft een groot bereik tegen relatief lage kosten.

In Nederland is het merendeel van de patiënten met knie- en heupartrose niet onder behandeling bij een zorgverlener. Echter, een grote groep van deze mensen ervaart wel problemen en heeft behoefte aan adequate informatie en begeleiding. Een laagdrempelig internet beweegprogramma zou een uitkomst kunnen bieden om fysieke inactieve patiënten met knie- en heupartrose te motiveren tot een actieve leefstijl.

Join2move

Voor zover wij weten is Join2move het eerste internet beweegprogramma voor mensen met knie- en heupartrose. Join2move richt zich op fysiek inactieve patiënten met knie- en heupartrose die niet onder behandeling zijn bij een zorgverlener. Het programma wordt aangeboden middels de website www.artroseinbeweging.nl. Deelnemers ontvangen elke week een nieuwe opdracht waarbij een zelfgekozen activiteit, zoals fietsen of lopen, negen weken lang stapsgewijs wordt opgebouwd. Deze opbouw van activiteiten is gebaseerd op de graded activity behandeling. Graded activity is een vorm van oefentherapie waarbij alledaagse activiteiten op geleide van tijd, en niet op geleide van pijn, worden uitgevoerd. Door geleidelijk meer te bewegen - ondanks de aanwezigheid van pijn- gaan patiënten inzien dat het pijnniveau niet perse gekoppeld is aan de mate van fysieke activiteit. Het uiteindelijke doel is dat patiënten oefeningen en fysieke activiteiten integreren in het dagelijks leven zodat een actievere leefstijl wordt gestimuleerd. Naast het vergroten van het activiteitenniveau behandelt Join2move onderwerpen zoals pijn, medicijnen, artrose en staan er video's op de website met mobiliteit- en spierkrachtoefeningen.

In het proefschrift komen de volgende vijf onderzoeksvragen aan de orde:

- Wat is de effectiviteit van bestaande internet beweegprogramma's bij mensen met een chronische ziekte? (hoofdstuk 2)
- Wat zijn de eerste effecten en ervaringen van patiënten met knie en/of heupartrose ten aanzien van het web-based beweegprogramma Join2move? (hoofdstuk 3)
- Wat is de effectiviteit van het Join2move programma bij mensen met knie- en/of heupartrose? (hoofdstuk 4)
- Welke factoren beïnvloeden het gebruik van het Join2move programma bij mensen met knie- en/of heupartrose (hoofdstuk 5)
- Wat is de relatie tussen psychologische factoren en fysieke activiteit bij mensen met knie- en/of heupartrose? (hoofdstuk6)

Een systematische literatuur studie

Hoofdstuk 2 presenteert een systematische literatuurstudie naar het effect van bestaande internet beweegprogramma's voor mensen met een chronische ziekte. Er is een uitgebreide zoekactie verricht in verschillende internet databases. Artikelen zijn geselecteerd indien (1) het onderzoek betrekking had op patiënten met een chronische aandoening; (2) onderzoek is gedaan naar een internet beweegprogramma; (3) de controlegroep geen behandeling of programma ontving. Uiteindelijk voldeden zeven studies aan deze inclusiecriteria waarvan vijf met een hoge methodologische kwaliteit. Vervolgens zijn de resultaten van de zeven studies samengevat. De resultaten laten een tegenstrijdig bewijs zien voor de effectiviteit van internet beweeginterventies. Het is dus onduidelijk of internet interventies het beweeggedrag van mensen met chronische ziekte kan beïnvloeden. Meer onderzoek is nodig om de werkelijke impact van deze internet interventies te bepalen.

De voorlopige effectiviteit en gebruiksvriendelijkheid van Join2move

In **hoofdstuk 3** wordt de opzet en uitvoering van een niet-gerandomiseerde pilotstudie beschreven waarin de eerste resultaten van de Join2move interventie worden gepresenteerd. In de pilotstudie hebben twintig patiënten met knie- en heupartrose het Join2move programma gevolgd. De primaire uitkomsten van het onderzoek zijn de mate van fysieke activiteit en fysiek functioneren. De metingen voor het onderzoek zijn verricht middels online

vragenlijsten en vonden plaats vóór deelname aan Join2move (baseline), tijdens het programma (6 weken) en na afloop van het programma (12 weken). De resultaten van de pilotstudie tonen aan dat deelnemers meer gingen bewegen. Na 6 en 12 weken nam het aantal minuten fysieke activiteit met respectievelijk 24% en 20% toe ten opzichte van de baseline waarden. Ten aanzien van het fysiek functioneren was vooruitgang binnen de groep kleiner en niet significant. Na de pilot studie zijn er interviews gehouden met deelnemers en zijn er twee verschillende gebruikerstesten uitgevoerd. De interviews waren gericht op de ervaringen van deelnemers met Join2move. Bij de gebruikerstesten hebben patiënten specifieke opdrachten uitgevoerd en hebben experts de website onderzocht middels een aantal gebruikscriteria. Tijdens het proces zijn er verschillende problemen met betrekking tot het gebruik gedetecteerd. Deelnemers beoordeelden het rigide karakter van de interventie als een nadeel. Gesteund door deze resultaten is er een functie ingebouwd die het mogelijk maakt om opdrachten te herhalen en het niveau aan te passen. Naast een aantal beperkingen waren gebruikers positief over Join2move. Over het algemeen vonden deelnemers het programma makkelijk in gebruik en de tevredenheid was hoog.

De effectiviteit van Join2move

Hoofdstuk 4 beschrijft de resultaten van een gerandomiseerd gecontroleerd onderzoek naar het effect van Join2move bij mensen met knie- en heupartrose. Een oproep voor deelname aan het onderzoek is geplaatst in het Noordhollands Dagblad, diverse lokale weekbladen en op verschillende websites. Deelnemers zijn geïncludeerd als zij voldeden aan de volgende criteria: (1) leeftijd tussen de 50-75 jaar; (2) zelf-gerapporteerde knie- en/of heupartrose; (3) zelf-gerapporteerde fysieke inactiviteit; (4) niet onder behandeling bij een zorgverlener in de afgelopen 6 maanden; (5) wekelijks toegang tot internet en (6) geen contra-indicaties voor fysieke activiteit. In totaal zijn 199 deelnemers op basis van toeval ingedeeld in twee groepen. 100 patiënten zijn toegewezen aan de Join2move-groep en 99 patiënten aan een controle groep. Mensen in de controle groep ontvingen geen behandeling. De primaire uitkomstmaten waren fysieke activiteit, fysiek functioneren en zelf ervaren herstel. Alle uitkomsten zijn verzameld vóór randomisatie, na 3 en 12 maanden. Zowel op korte (3 maanden) als op lange

termijn (12 maanden) zijn er statistisch significante effecten gevonden in het voordeel van de Join2move-groep. Dit wil zeggen dat verschillen tussen de twee groepen niet op toeval berusten maar hoogstwaarschijnlijk het effect zijn van het internet programma Join2move. Na drie maanden functioneerden patiënten in de Join2move-groep beter in het dagelijks leven in vergelijking met de controle groep. Activiteiten zoals traplopen, hurken, wandelen en boodschappen doen werden makkelijker uitgevoerd. Na drie maanden rapporteerde 44% van de interventiegroep een verbetering in zelf ervaren herstel, in de controlegroep was dit slechts 7%. Er zijn geen significante effecten gevonden ten aanzien van de fysieke activiteit. Na één jaar bleken de personen in de interventiegroep wel significant meer te bewegen dan de controle groep. Ten aanzien van het dagelijks functioneren en zelf ervaren herstel was dit effect na een jaar niet meer te zien.

In tegenstelling tot onze aanvankelijke verwachtingen ging de verhoging in fysieke activiteit niet gepaard met beter fysiek functioneren. Uit eerder onderzoek blijkt dat meer bewegen geassocieerd is met een verbeterd fysiek functioneren bij patiënten met knie en/of heupartrose. Hoewel een definitieve verklaring voor de afwijkende bevindingen niet te geven is, is het mogelijk dat de vragenlijst in deze studie niet sensitief genoeg is geweest om veranderingen in gematigde recreatieve activiteiten waar te nemen. Dit zou kunnen verklaren waarom de veranderingen in fysieke activiteit niet gepaard zijn gegaan met veranderingen in fysiek functioneren.

Het gebruik van Join2move

In **hoofdstuk 5** worden de resultaten van een mixed methods studie gepresenteerd. In deze studie is zowel een kwantitatieve als kwalitatieve methode gebruikt om inzicht te krijgen in factoren die van invloed zijn op het gebruik van het Join2move programma. Meer inzicht welke factoren bepalend zijn voor het gebruik is belangrijk om Join2move verder te optimaliseren. De studie maakt gebruik van gegevens van de 100 individuen in de interventie groep. Data van de controlegroep zijn niet meegenomen in deze studie. Voor het kwantitatieve deel zijn demografische, klinische en psychologische variabelen gebruikt om een multivariaat predictiemodel te

bouwen. Voor de kwalitatieve methode zijn er semigestructureerde interviews afgenomen.

In vergelijking met andere studies kan de mate van gebruik als gemiddeld worden beschouwd. Van de 100 deelnemers die een wachtwoord en gebruikersnaam hebben ontvangen voltooide 46 gebruikers tenminste zes van de negen opdrachten (gebruikersgroep). De overige 54 personen voltooide minder dan zes opdrachten (niet gebruikersgroep). In deze mixed methods studie zijn deze twee groepen met elkaar vergeleken. Uit de multivariate regressie analyse is gebleken dat een hogere leeftijd en het hebben van co-morbiditeit de kans vergroot op het niet gebruiken van de interventie. Verder lieten de resultaten uit de interviews zien dat de afwezigheid van persoonlijke begeleiding, afwezigheid van motivatie, fysieke problematiek en een sombere stemming het gebruik van Join2move ook belemmerde. Factoren die het gebruik juist positief beïnvloeden waren vertrouwen in en betrouwbaarheid van de interventie, ondersteuning vanuit sociale omgeving en toewijding aan het onderzoeksteam. Join2move is een programma zonder begeleiding wat bepaalde voordelen heeft, met name gerelateerd aan kosten, bereik en toegang. Toch lijken ouderen en patiënten met meerdere aandoeningen baat te hebben bij meer persoonlijke begeleiding. Voor deze groep is een blended vorm van Join2move - combinatie met persoonlijke begeleiding- veelbelovend.

De relatie tussen psychologische factoren en fysieke activiteit

Hoofdstuk 6 is een studie naar de cross-sectionele en longitudinale relatie tussen psychologische factoren en fysieke activiteit bij mensen met knie- en heupartrose. In deze studie zijn de baseline, 3 en 12 maanden metingen van de interventiegroep gebruikt (zie hoofdstuk 4). De vijf psychologische variabelen die in deze studie zijn onderzocht zijn: omgaan met pijn, locus of control (mate van controle met betrekking tot eigen gezondheid), depressie, angst, zelfeffectiviteit (vertrouwen in eigen kunnen). Uit de cross-sectionele analyses (analyses op één punt in de tijd) blijkt dat een passieve manier van omgaan met pijn samengaat met verminderde fysieke activiteit. Overige cross-sectionele associaties tussen psychologische factoren en fysieke activiteit waren niet statistisch significant. Uit de longitudinale analyses

(analyses op verschillende momenten in de tijd) is gebleken dat verbeteringen in zelfeffectiviteit en verminderde interne locus of control geassocieerd waren met meer fysieke activiteit. De bevindingen van hoofdstuk 6 bevestigen ander onderzoek waaruit blijkt dat zelfeffectiviteit een belangrijke rol speelt in het verhogen van fysieke activiteit. Op basis van deze resultaten lijkt het stimuleren van zelfeffectiviteit een belangrijke voorwaarde om het niveau van fysieke activiteit bij mensen met knie- en heupartrose te verhogen.

Discussie

In **hoofdstuk 7** worden de bevindingen van dit proefschrift besproken. Tevens worden enkele methodologische overwegingen bediscussieerd en worden er aanbevelingen gedaan voor de praktijk. Tot slot eindigt het proefschrift met een sectie met suggesties voor toekomstig onderzoek. Op basis van de resultaten uit het gerandomiseerde onderzoek kan geconcludeerd worden dat het Join2move programma effectief is. Het Join2move programma zou uitstekend kunnen passen in de eerste fase van de conservatieve behandeling van knie- en heupartrose. Aangezien er een gebrek is aan zelfmanagement materialen hebben zorgverleners met het Join2move programma een effectief middel in handen om inactieve patiënten met knie- en heupartrose te motiveren tot een actievere leefstijl.

Een sterk punt van dit proefschrift is dat er gebruik is gemaakt van een gerandomiseerde en gecontroleerde studie naar de effectiviteit van Join2move. Echter, het manuscript heeft ook enkele beperkingen. De eerste beperking is dat de patiënten geïncludeerd zijn op basis van zelf gerapporteerde knie- en heupartrose. Hierdoor kan niet met zekerheid gezegd worden dat alle patiënten ook daadwerkelijk artrose hebben gehad. Een tweede beperking betreft de externe validiteit. In het algemeen waren deelnemers gezond en hoogopgeleide patiënten. Hierdoor zijn de resultaten van het proefschrift beperkt generaliseerbaar. Vervolgonderzoek zal zich daarom meer moeten richten op laagopgeleide mensen met een ongezonde leefstijl.

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Franse Pyreneeën, Col de Peyresourde, Augustus 1998 (15 jaar)

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Curriculum vitae

Daniël Bossen was born in Bergen (NH), the Netherlands, on 23 June 1983. He followed his secondary education at the Adriaan Roland Holstschool in Bergen, from which he graduated in 2003. After secondary school he started studying physiotherapy at the Hogeschool van Amsterdam. After graduation in 2007, he started working as a physiotherapist in the primary care setting. Additionally, he started studying health sciences at the Vrije Universiteit van Amsterdam. In 2009, he obtained the title of Master of Science in Health Sciences. Subsequently, he worked as researcher at the NIVEL institute where he conducted his PhD-research on the effectiveness of a web-based physical activity intervention for patients with knee and hip osteoarthritis. The results of this research are described in this thesis. Currently, he is still working at the NIVEL institute as a post-doc researcher in the field of eHealth. In addition to his work activities at NIVEL, he will start a new job as a teacher/researcher at the Hogeschool van Amsterdam.